Establishing alternative sets

doctor philosophiae (Dr. phil.)

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eingereicht an der Philosophischen Fakultät II
Dekan/In: Prof. Dr. Helga Schwalm
Humboldt-Universität zu Berlin
Datum der Einreichung: 18.06.2014
Datum der Disputation: 30.01.2015

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To my family: my parents and Nano.

Acknowledgements

I would like to thank first and foremost Katharina Spalek who guided me throughout this dissertation and strongly supported my personal development. Working within the SFB 632 Information Structure, in particular in our project, has been a real pleasure for me. This dissertation greatly benefited from the help and support of our group, including Katharina Spalek, Isabell Wartenburger, Juliane Burmester as well as our student assistants, Janine Klose, Vinzent Müller and Linda Giesel.

I am grateful to Manfred Krifka for his support, especially concerning the theoretical framework of this thesis. I am also thankful to Hubert Truckenbrodt, Andreas Haida, Tue Trinh, Daniel Hole and Malte Zimmermann for insightful comments on theoretical aspects. For helpful discussion of the experiments, I would like to thank all researchers from our psycholinguistics lab, in particular Sophie Repp, Berry Claus, Hannah Bohle and Anna Czypionka.

There are numerous other people who gave useful advice including especially Jesse Harris, Jacopo Romoli, Daniele Panizza, Matt Husband, Mary Byram-Washburn, Christina Kim, Judith Degen, Filippo Domaneschi and Jack Tomlinson. I would like to highlight two people who basically accompanied this whole journey, Duane Watson and Brian Leahy.

I am truly indebted to Stephanie Solt, my first Jedi Master, who practically raised me and continues to inspire me. I owe to her invaluable support during the early steps of my research career as well as continuing support. She is the reason I am able to try bridging the gap between formal linguistic theories and psycholinguistic research.

I would also like to express my gratitude to the language acquisition group at the Centre for Cognition and its Disorders (Macquarie University), in particular Rozz Thornton, Cory Bill, Kelly Rombough, Elena D'Onofrio, Peng Zhou and Shasha Ahn. The group has provided an ideal environment for me to finish my dissertation. Very warm and special thanks go to Stephen Crain for his invaluable advice on so many levels. In this short period of time, he has influenced my thinking more than any other scientist I have ever met. He will be my role model for the rest of my career.

On a personal level, I would like to thank two very special persons, Madeleine and Jenny. Finally, the greatest deal of support came from my family: my parents and Nano, the love of my life. I am indebted to Nano for his patience in giving millions of judgements of notorious sentences like *Anna only ate a banana* and for at least trying to prevent me from attenuating to the word *only* in every possible sentence. He, my parents and the greater Berlin family are most certainly the reasons why I haven't progressed too far along the academic Asperger's syndrome scale while writing this dissertation.

Last but not least I thank the words *only* and *also*. The given list of people is certainly not exhaustive.

Zusammenfassung

Die Alternativensemantik nach (Rooth, 1985, 1992) geht davon aus, dass sprachlicher Fokus eine Menge von Alternativen evoziert und Fokuspartikeln auf diese Menge Bezug nehmen. Die vorliegende Dissertation untersucht den Einfluss von Fokuspartikeln und prosodischem Fokus auf die mentale Repräsentation von Alternativenmengen. Im Speziellen wurden die sprachlichen und kognitiven Mechanismen, die am Aufbau einer Alternativenmenge beteiligt sind, mittels psycholinguistischer Experimente getestet.

Experiment 1a und 1b untersuchen späte Repräsentation der gesamten Alternativenmenge. Die Experimente zeigen, dass Fokuspartikeln zu einer reicheren Enkodierung der Alternativenmenge führen, was sich in einem verbesserten Gedächtnisabruf äußert. Experiment 2 und 3 untersuchen die Prozesse, die am Aufbau von Alternativenmengen beteiligt sind. In Experiment 2 (*Probe Recognition*) führten Fokuspartikeln zu Interferenzeffekten beim Erkennen von erwähnten Alternativen sowie bei der Ablehnung nicht-erwähnter Alternativen. Eine weitere Analyse und Experiment 4 untersuchen die Mitglieder der Alternativenmenge. Die Daten deuten darauf hin, dass die Alternativenmenge aus sämtlichen möglichen Ersetzungen des fokussierten Elements inklusive unrelatierter Elemente besteht. Im Vergleich von intonatorischem Fokus und Fokuspartikeln (Experiment 5 und 6) zeigte sich, dass Fokus den Abruf von kontextuellen Alternativen erleichtert während Fokuspartikeln zu zusätzlichen Kompetitionseffekten führen.

Im Allgemeinen liefert deutet die vorliegende Dissertation darauf hin, dass intonatorischer Fokus eine Alternativenmenge im Kopf des Hörers

evoziert und dabei hilft relevante Alternativen zu identifizieren. Fokuspartikeln haben eine zusätzliche Funktion und fhren während der Sprachverarbeitung zu einem stärkeren Wettbewerb zwischen Mitgliedern der Alternativenmenge.

Abstract

According to Rooth' alternative semantics (Rooth, 1985, 1992), focus evokes a set of alternatives and that focus particles make reference to this set. The present thesis examines the impact of focus particles and intonational focus on the mental representation of alternatives. In particular, it explores the linguistic and cognitive mechanisms that underlie the establishment of alternative sets in a series of psycholinguistic experiments.

Two delayed recall experiments (Exp. 1a and 1b) revealed that participants were better at recalling mentioned alternatives to a focused element when the discourse contained the particles *only* or *even*. Experiments 2 and 3 found interference effects of focus particles in the recognition of mentioned alternatives and the rejection of unmentioned alternatives. An additional analysis and Experiment 4 indicate that the set of alternatives consists of various possible replacements of the focused element. Experiment 5 showed that contrastive accents facilitated the retrieval of alternatives while focus particles caused interference effects relative to the condition with an L+H* accent.

Overall, this thesis indicates that intonational focus activates alternatives in the listeners mind and helps identifying relevant alternatives. Focus particles, on the other hand, cause stronger competition between the focused element and its alternatives.

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Chapter 1

Introduction

1.1 What this dissertation is about

Focus particles like *only* and *also* are used pervasively, they play an important role in child language as well as in advertising. For naive speakers, however, such particles seem to be inconspicuous. So, what is the function of focus particles and what makes them special? Particles like *only* change the basic meaning of an utterance. Consider the sentences in (1).

(1) Context: Madeleine and Sebastian were standing on the dance floor

a. Madeleine started dancing

b. **Only** Madeleine started dancing

Sentence (1)-a expresses that Madeleine started dancing but does not inform us about Sebastian. Sentence (1)-b, on the other hand, expresses that nobody apart from Madeleine started dancing. In fact, the sentence is only a true description of the scene if Sebastian did not start dancing. This exclusive meaning component is part of the semantics of *only*, therefore it is automatically conveyed. As can be seen from those two examples, the sentence with *only* makes a more informative statement than the one without the particle.

More specifically, focus particles make a statement about **alternatives**. We refer to alternatives as elements that could have been used in a sentence, for example the contextually-mentioned alternative *Sebastian* in (1). Interestingly,

such alternatives do not need to be mentioned explicitly, but listeners can infer them. The tag line by an artist's team displayed in Figure 1.1 below plays with exactly this phenomenon.

Figure 1.1: *Dancing is ALSO a sport* (http://wupwup.com/artists/)

The slogan is to be read with stress on the particle *auch* ('also'), which has a so-called additive meaning component. The particle in the sentence expresses that dancing is a sport, in addition to other types of sport.[1] Intuitively, reading the slogan *Tanzen ist auch Sport* (*dancing is ALSO a sport*) makes us imagine other kinds of sport and compare them to what might make dancing itself a sport. So, the slogan makes use of the fact that words like *also* trigger a search for alternatives that are compared with the proposition of the sentence. Technically, the mentioned element of the sentence under consideration (e.g., *Tanzen* or *Madeleine* in the above example) is part of the alternative set. We will refer to this element as the **focused element**. The focused element is selected from a larger set of alternatives and in this sense it is compared with the alternatives.

The goal of this thesis is to explore how the representation of alternatives evolves in the listener's mind. The leading research question is by what linguistic and cognitive mechanisms listeners create the set of alternatives. In a series of psycholinguistic experiments, I will demonstrate that particles like *only* and *also* do exactly what the slogan *Tanzen ist auch Sport* is playing with. First, they

[1]There are two possible readings of the slogan depending on whether *auch* associates with the subject or object. As already mentioned, the slogan is to be read with stress on *auch*, which indicates that the domain of the particle is the subject of the sentence (unstressed *auch* instead associates with the object).

evoke a set of alternatives in the comprehender's mind. Second, they instigate a comparison/competition between items that could replace the focused element.

This dissertation is further concerned with the composition of the alternative set (which elements are included in such a set) and the question of how linguistic focus and focus particles conjunctively affect the representation of alternatives.

1.2 Focus, alternative semantics and focus particles

Particles like *only* and *also* are said to be focus-sensitive (e.g., Jackendoff, 1972 and Rooth, 1985). They associate with an expression in focus and depending on which part of the sentence is focused, its truth conditions change. But let us start out by exploring what linguistic focus is. The focus of a sentence intuitively indicates the informational importance of the respective word or phrase. Consider the following question-answer pair:

(2) a. Who was dancing?
b. [Madeleine]$_{\mathrm{F}}$ was dancing

In (2) the question introduces a predicate and asks for a person. The answer provides the relevant person and is therefore considered to be congruent with the question. Crucially, the position of focus in the answer corresponds to the question; in example (2) *Madeleine* is focused as indicated by the subscript *F*. Intuitively, it seems that *Madeleine* is the most important element of the sentence since the question asked for a person and all other information was given beforehand. Typically, the focused word will bear the greatest prosodic prominence of the utterance.

While it seems to hold true in many cases that the element in focus is prosodically prominent and informationally important, several challenges to this account have led to the proposal of a different notion of focus (see Krifka, 2007 for a discussion and an overview of the different notions of focus). According to Rooth (1985), the defining feature of focus is to evoke alternative expressions that can replace the element in focus (Rooth, 1985, 1992). So, instead of highlighting

prominence *per se*, alternative semantic theories define focus as indicating the presence of alternatives that are relevant for interpretation (see also Jacobs, 1983, Jacobs, 1988 and Krifka, 2007 for the proposal that focus evokes alternatives). What does it mean for a focused expression to evoke an alternative set? If we again take the example *Madeleine was dancing*, the theory claims that the focus on the word *Madeleine* creates a representation of other persons that could have been dancing (for example Sebastian but also other relevant persons).

Simple intonational focus as in the above example introduces a set of alternatives. The focus particle *only* makes a further statement about the alternatives. In the sentence *Only Madeleine was dancing*, the particle *only* asserts that no-one other than Madeleine was dancing. This exclusive meaning component is part of the semantics of *only*, i.e. it is conventionalized.

The particle *also*, in turn, has an additive meaning component. It expresses that the statement holds for the focused element and presupposes that it holds for at least one other alternative. Hence, exclusive particles (*only*) and additive particles (*also*) have different meaning components. Intonational focus and focus particles further differ in the strength of dependence on focus alternatives (Beaver & Clark, 2008). Intonational focus introduces an alternative set while the semantics of focus particles requires such a set. These theoretical distinctions will be presented in detail in Chapter 2. For now, this brief overview suffices to sketch the research questions of this thesis.

1.3 Specific research questions

The present dissertation takes the alternative semantic account developed by Rooth (1985, 1992) as a starting point and derives from it hypotheses for language processing and the cognitive representation of alternatives. In particular, I investigate the construction of alternative sets, how the representation of alternatives unfolds with time and which elements are included in the alternative set.

As was described above, linguistic focus evokes a set of alternatives and focus particles make a further statement about this set. Since intonational focus, exclusive and additive focus particles factor alternatives differently into meaning, they

might differentially affect the representation/processing of focus alternatives. I will therefore compare the impact of pitch accenting and focus particles on the representation of alternatives.

The specific research questions of this thesis are summarized below. After providing a theoretical overview in Chapter 2, the specific research questions will be thoroughly introduced in each corresponding chapter.

1. How is the set of alternatives represented in long-term memory? Do focus particles enhance memory for focus alternatives? (Chapter 3)

2. By what linguistic and cognitive mechanisms is the set of alternatives established? How do focus particles affect these mechanisms? (Chapter 4)

3. What elements are included in the set of alternatives? (Chapter 5)

4. How do the effects of focus particles compare to that of contrastive pitch accents? (Chapter 6)

1.4 Overview of the thesis

This dissertation examines the impact of focus particles and intonational focus on the representation of focus alternatives. I will start out by showing that focus particles enhance long-term memory for contextual alternatives. I will then turn towards more immediate representations of focus alternatives and the mechanisms by which alternative sets are established. I will argue that focus particles cause an active search for elements that can replace the focused element. That is, activation flows to a cohort of semantic competitors involving mentioned as well as unmentioned alternatives. Focus particles lead to strong competition among members of the alternative set. Overall, the experiments suggest that intonational focus introduces alternatives or helps identifying the relevant alternatives. Focus particles cause an additional competition among focused element and its alternatives by highlighting the relation among the two.

The thesis is organized as follows: Chapter 2 provides an in-depth overview of the theoretical and empirical background of the thesis. I will explore the notion

of focus, different focal accent types, the semantics of focus operators as well as relevant factors that influence the perception of contrast. I will then turn to previous studies that investigated the impact of focus on memory representations and the role of alternatives in online processing.

Chapter 3 presents the results of two delayed recall experiments (Exp. 1a and 1b) investigating the impact of focus operators on long-term memory for alternative sets. The experiments revealed that participants were better at recalling alternatives to a focused element when a prior discourse contained either the particle *only* or *even*. Overall, the focused element was recalled better than the alternatives. This pattern of results was replicated with narrative discourses indicating that the effects of focus particle generalize over different linguistic contexts. These experiments provide initial support for the idea that the semantics of focus particles evokes a set of alternatives in the listener's mind and renders those alternatives salient. Similar effects were observed for exclusive and additive particles. Therefore, it is argued that focus operators make alternatives salient because their lexical entry requires an alternative set independent of the specific meaning components conveyed by the two types of particles.

Chapter 4 is devoted to the mechanisms by which the alternative set is established and presents a probe recognition and a lexical decision experiment. Experiment 2 found that focus particles interfere with the recognition of mentioned alternatives and the rejection of unmentioned alternatives. Lexical decision study 3 shows that mentioned and unmentioned alternatives become activated in comparison with unrelated items. The specific contribution of focus particles is an interference effect (relative to a condition with bare intonational focus). The two experiments hence suggest that establishing an alternative set involves activation and competition mechanisms. Further, the experiments indicate that competition is stronger in the case of focus particles compared to bare intonational focus.

Chapter 5 looks closely at the restriction of the alternative set and the members included in this set. I will compare two different theoretical proposals: a permissive and a restrictive account. The permissive account by Rooth (1985, 1992) assumes that the set of alternatives consists of various possible replacements. Other restrictive theories (e.g., Wagner, 2006), on the other hand, systematically

exclude certain alternatives from consideration. An additional analysis of Experiment 3 showed that unrelated items become activated if they are a possible replacement of the focused element, to a similar extent as semantically-related alternatives. This finding is in line with the permissive view by Rooth. Experiment 4 asked whether the observed interference effects of focus particles are based on general semantic mechanisms or whether there is a more specialized mechanism tuned to focus alternatives. It was found that interference effects were present for alternatives by definition (i.e., possible replacements) but not for general semantic associates (non-replacements that were associated with the focused element by world knowledge). Experiment 4 further indicated that discourse mention is not necessary in the establishment of alternative sets.

Chapter 6 starts exploring the specific role of intonational focus. I will directly compare the impact of H* and L+H* as well as the combination of focus particles with L+H* accents on the retrieval of alternatives. Since timing seems to play a crucial role for the establishment of alternative sets, Experiments 5 and 6 incorporate temporal delay as a variable in the experimental design. Experiment 5 shows that contrastive accents facilitate the retrieval of alternatives when including one filler sentence before the recognition test while focus particles cause interference effects. In Experiment 6, the temporal delay between presentation and recognition test was extended by including a numeric distractor task. Under these circumstances, the facilitatory effects of contrastive accents vanished and the particle *only* again interfered with the recognition of mentioned alternatives. In conjunction, the results indicate that intonational focus helps identifying the relevant alternatives and that focus particles have an additional function in that they highlight the dependence of the focused element on a set of alternatives.

Chapter 7 presents the conclusions of this thesis. I will summarize all findings and explore their significance for theories of focus, inference computation and language processing research. Overall, the thesis provides pervasive evidence for the psychological reality of Rooth' alternative semantics. It further shows that alternative sets are an important cognitive unit concurring with the processing/representation of focal information.

Chapter 2

Theoretical and empirical background

This chapter provides an overview of the theoretical and empirical background of this thesis. The first part of this chapter presents the relevant theoretical concepts while the second part discusses previous findings on the role of focus structure in language processing and the representation of focus alternatives.

2.1 Theoretical background

In Section 2.1., I outline the definition of focus and association with focus in alternative semantics. According to alternative semantics, focus evokes a set of alternatives while focus particles establish an association between the focused element and its alternatives. I will discuss whether the notion of (contrastive) focus is reserved to specific pitch accent types. The following sections explore the meaning components of focus particles and compare the inferences triggered by focus particles with that of bare intonational focus. The final part of Section 2.1. summarizes factors that influence the perception of contrastiveness.

2.1.1 Focus in alternative semantics

Focus The theory of focus referred to as alternative semantics was proposed in the dissertation of Rooth (1985) and further developed in Rooth (1992). Accord-

ing to alternative semantics, a focused expression has two meaning components, an ordinary value and a focus semantic value. Rooth gives the following example in (1-a) presented below (Rooth, 1992, p. 2).

(1) a. Mary likes $[\text{Sue}]_{\text{F}}$
b. Ordinary value $[\![\cdot]\!]^o$: like (Mary, Sue)
c. Focus semantic value $[\![\cdot]\!]^f$: like (Mary, x|x $\in E$), where E is the domain of individuals

The ordinary value of the sentence *Mary likes SUE* corresponds to its usual meaning as derived by compositional semantics. The focus semantic value consists of a set of elements that match the focused element in type. This so-called alternative set is derived by replacing the focused element with other suitable elements of the same semantic type (*Mary likes x*). The intuition is that focus evokes a set of alternatives: In the given example this amounts to a set of persons Mary might like. The focus on *Sue* indicates that other alternatives are relevant for interpreting the sentence (Krifka, 2007). It should be noted that alternatives are situated at the level of denotation. That is, in the cases relevant for this dissertation we are talking about alternative concepts not expressions (see Krifka, 2007 for a discussion of focus on expressions).

Crucially, the location of focus determines the set of possible replacements. For example, when the subject *Mary* is focused instead of the object *Sue*, the alternative set consists of possible replacements of the form *y likes Mary*. According to Rooth (1985), alternatives at the constituent level project to the sentence level. Evoking or providing a set of alternatives is the primary function of focus in alternative semantics.

It is debated whether focus induces a contrast in the sense that what is true for the focused element does not hold for other alternatives (see especially Sections 2.1.2 and 2.1.5). In Rooth' alternative semantics, the focused element is always part of/a subset of the focus semantic value (alternative set) and the two potentially contrast or are compared. Since the focused element is drawn from the set of alternatives it has, in some sense, a special status among the alternative set. However, what is not part of the semantics of focus is that the other alternatives are excluded or negated. In fact, Rooth (1992) "strips away" any

notion of contrast in the definition of focus (and association with focus). Yet, contrastive effects (e.g., the exclusion of alternatives) might arise pragmatically in certain contexts (see Section 2.1.4).

Association with focus Certain lexical items establish a particular relation with an element in focus. Jackendoff (1972) first observed that focus particles associate with an element in focus, which bears a nuclear accent. Particles like *only* are focus sensitive since the placement of focus leads to different truth conditions of the corresponding sentence. Consider the sentences displayed below. In sentence (2)-a, the particle *only* associates with the object and hence the sentence expresses that Mary hugged no other person than Peter. The placement of focus on the verb in sentence (2)-b, however, leads to a different meaning: Mary hugged Peter instead of for example kissing him. The phenomenon just described is referred to as focus sensitivity.

(2) a. Mary only hugged $[\text{Peter}]_{\text{F}}$
b. Mary only $[\text{hugged}]_{\text{F}}$ Peter

Similar examples of association with focus provided the starting point for the theory of focus proposed in Rooth (1985). In the original conception, the focus semantic value (i.e., the whole set of formal alternatives) is the domain of quantification of focus particles. However, as Rooth (1992) points out sometimes this set may be very small. He notes that in the example sentence *Mary* $[\textit{read}]_F$ *the Recognitions* it would be undesirable to assume that all possible replacements of the verb are relevant. Instead the relevant alternative set likely only involves the propositions *Mary read the Recognitions* and *Mary understood the Recognitions*. Umbach (2001) discusses contextual restriction of sentences with focus particles. She points out that a sentence like *In the bar, Paul only saw* $[\textit{Ansgar}]_F$ could never be true/appropriate if all possible replacements of the focused element were negated by *only*. For example, the given sentence probably does not exclude that Paul saw the bar keeper.

Hence, the alternative set has to be restricted in some way (see also Blok & Eberle, 1999 for a discussion of this point). In Rooth (1992), such a restriction is achieved by introducing a free variable C, which is a subset of the focus semantic

value. Note that Rooth does not equate C with the contextual set of alternatives but that C is a free covert variable in LF, which is a subset of the focus semantic value. C is not only constrained by focus but also by other contextual and pragmatic factors (for example by frequency and recency). The idea is that the value of C is not uniquely fixed semantically but rather it is fixed externally by a pragmatic process. Ultimately, the value of C is determined by a process of anaphora resolution and not by compositional semantics (see also von Fintel, 1994). In a standard case, C gets bound by a contextually-given antecedent.

Rooth' approach has the flexibility to capture a variety of focus sensitive phenomena but it leaves the matter of (contextual) restriction entirely open to pragmatics (see especially Kim, 2012 for experiments on contextual restriction in focus interpretation). Hence, the set of formal alternatives (the focus semantic value derived by grammatical substitutions) can be regarded as separate from the contextual set of alternatives in the account by Rooth (see Fox & Katzir, 2011 for a discussion of this aspect).

In Rooth (1992), focus particles do not quantify over the whole set of alternatives but over the variable C. The main idea pursued in this account is that all focus-related effects are optional (Rooth, 1992, p.32). However, Rooth maintains that focus particles (as a special case) grammatically depend on association with focus, in other words that they require a set of alternatives. This idea was further developed in Beaver & Clark (2008) who established a system of different degrees of association with focus (conventional, free and quasi association) to distinguish semantic and pragmatic forces. In their system, focus particles establish a conventional association with focus, indicating "strong" grammatical dependence on the alternative set.[1]

So far, I have provided an overview of the grammatical function of focus (as assumed in alternative semantics). An important question, which is to some extent intertwined with the question about function, concerns the realization of focus. I will give an overview of the relevant aspects of this discussion in the following section.

[1] Adverbs of quantification like *always*, on the other hand, freely associate with focus.

2.1.2 Different accent types

The definition of focus in alternative semantics states that focus marking (in grammatical terms) should only be applied in cases where alternatives are involved in the interpretation of an utterance but nothing is claimed about how focus is exactly realized (Krifka, 2007, p.7). In intonation languages like English and German, focus is usually marked by a pitch accent (in auditory speech). There is, however, an open theoretical debate whether intonational focus is reserved to specific accent types or intonational contours (e.g., Pierrehumbert & Hirschberg, 1990, Selkirk, 2002, Rochemont, 1986). More generally, there is no consensus whether grammar distinguishes between different types of focus such as contrastive focus (focus as evoking alternatives) on the one hand and new information focus on the other hand, where new information roughly corresponds to the information not previously shared by speaker and hearer (Rochemont, 1986, Selkirk, 2002, Selkirk, 2008, Rochemont, 2013). A full discussion of the different notions of focus and focus marking systems goes beyond the scope of this dissertation (I refer the interested reader to Rochemont, 2013 for a recent overview of the debate). Most relevant for the present thesis is the debate concerning the representations and usages underlying focal pitch accents.

It is uncontroversial that new information and contrastive focus are both coded by some sort of linguistic prominence (Gundel & Fretheim, 2004). However, there is considerable disagreement as to whether the two are associated with different pitch accent types. Pierrehumbert (1980) proposed a categorization of accent types into high (H) and low (L) targets. In her approach, a simplex H* pitch accent is distinguished from a complex L+H* accent (corresponding roughly to a distinction between A and B accents in Jackendoff, 1972). The H* accent consists of a single high target on the accented syllable while the L+H* accent starts with a low initial target followed by a steep rise to a high target (Pierrehumbert, 1980). Pierrehumbert & Hirschberg (1990) proposed that these two accent types are associated with distinct categorical meanings. While the H* accent signals new non-contrastive information, the L+H* is associated with a contrastive or corrective interpretation in their view. Some evidence in favor of such a distinction was found in production and perception experiments by Alter

et al. (2001), Selkirk (2002), Ito *et al.* (2004) and Krahmer & Swerts (2001)[2], amongst others.

However, it is debated in the literature whether the L+H* accent and the H* form two discrete categories or rather are two variants of the same pitch accent (see for example Krahmer & Swerts, 2001 and Wagner & Watson, 2010 for an overview). The ongoing debate concerns the acoustic properties that drive the perception of the two accents as well as their interpretation. It is unclear whether the difference is realized by accent type (i.e., a categorical distinction) or rather by gradual prosodic differences (as found for example by Bartels & Kingston, 1994). Moreover, the prosodic context in which the accented item occurs might play a decisive role (e.g., Krahmer & Swerts, 2001). Concerning the corresponding interpretation, H* and L+H* accents might vary only in the prominence/salience or size of the alternative set (see for example Watson *et al.*, 2008 and Calhoun, 2009) rather than representing different types of focus.

Independent of the exact theoretical status, prosodic studies indicate that contrastive accents have a higher pitch excursion, longer duration and intensity than non-contrastive accents (Bartels & Kingston, 1994, Selkirk, 2002, Baumann *et al.*, 2006, Katz & Selkirk, 2011, see also Kügler & Gollrad, 2015). Perception studies further showed that contrastively-accented constituents are perceived as more prominent and contrastive than constituents carrying non-contrastive stress (i.e., either the more salient the alternatives are or the more likely they are interpreted as corrective: e.g., Bartels & Kingston, 1994, Krahmer & Swerts, 2001 Alter *et al.*, 2001, Ito *et al.*, 2004, Ito & Speer, 2008 and Watson *et al.*, 2008).

In the following, I will use L+H* and H* as labels for the two accent types (in line with the TOBI labeling system: see Silverman *et al.*, 1992 for English and Grice & Baumann, 2002 for German) without implying any particular theoretical account of the distinction. Psycholinguistic experiments about the representation of alternatives might provide insights into the theoretical debate. For example, a visual world study by Watson *et al.* (2008) suggested that the interpretation of the two accent types might overlap in that H* accents are consistent with new and

[2]Though the study by Krahmer & Swerts (2001) showed that it was not necessarily accent type only that distinguished contrastive and non-contrastive accents.

contrastive referents while L+H* create a bias towards contrastive referents. This question will be further explored in Chapter 6 (see also Ito *et al.*, 2004, Weber *et al.*, 2006 and Ito & Speer, 2008 who found L+H* accents favor contrastive referents as well as Wagner & Watson, 2010 for an overview of experimental work on prosody). Generally, it should be noted that newness and contrastiveness may be orthogonal dimensions of focus.

After having discussed the realization of focus, I will turn to the interpretation and different meaning components of focus particles. I will further compare the interpretation of focus particles to contrastive pitch accents.

2.1.3 Groups of focus particles

As was noted before, focus particles associate with an expression that bears (intonational) focus. The theory by Rooth (1985, 1992) provides an account of how association with focus is established grammatically. Regarding the associated meaning components of focus particles, König (1991) proposed a distinction of focus particles into groups of exclusives (e.g., *only*, *merely*), additives (e.g., *also*) and scalars (e.g., *even*).

Exclusive particles like *only* assert that contextually-relevant alternatives are not true of the proposition. For example, in the sentence *Mary only invited [John]$_F$ to dinner*, the function of the particle *only* is to exclude elements of the alternative set {Peter, Sue, ...} thereby expressing that no-one other than John was invited (König, 1991). In the case of exclusives, the focused element is the only element that leads to a true assertion within a contextually-restricted set of alternatives.

Additives like *also* presuppose the truth of alternative propositions. In other words, when uttering a sentence with *also* a set of alternatives has to be established in the prior context or at least it must be possible to accommodate it. The meaning contribution of *also* is to express that a statement holds for the focused element in addition to some alternative. For example, the sentence *Mary also invited [John]$_F$ to dinner* presupposes that Mary invited at least one other individual referred to in the context.

König (1991) further identifies a presupposition of likelihood in scalar particles like *even*. That is, a particle like *even* presupposes a scale among which the elements of the alternative set are ordered, and assigns lowest value to the focused element. The sentence *Mary even invited John* conveys that it is surprising or unexpected for the speaker that John was invited among other people who were invited. Hence, *even* carries an additive presupposition (similar to *also*) as well as a scalar presupposition of likelihood.

There is certainly a lot more to say about the semantics of focus particles (for an overview see Beaver & Clark, 2008) as well as the syntax of the different types of particles (see for example Rooth, 1985). However, for the present dissertation this overview is sufficient.

2.1.4 Comparison of inferences triggered by contrastive accents and focus particles

Apart from the fact that focus particles and pitch accents belong to a different linguistic level, the inferences triggered by additive, exclusive particles and contrastive accents have a different status. I have already noted that focus particles contribute quantificational force to a sentence. Focus particles quantify the value of the focused element over the set of alternatives and have a truth conditional impact. Intonational focus, on the other hand, does not have a truth conditional impact. Consider the following example found in Rooth (1985):

(3) a. Carl likes [herring]$_{\mathrm{F}}$
    b. [Carl]$_{\mathrm{F}}$ likes herring

Focusing either *Carl* or *herring* in (3) does not make a difference in truth conditions of the above sentence: the sentence will be true or false depending on the matter of facts but independent of which part of the sentence is focused (either it is true that Carl likes herring or not). However, as is noted in Rooth (1992), focus affects the pragmatic inferences arising from the sentence. The sentence *Carl likes [herring]$_F$* triggers the exhaustive/exclusive implicature that Carl does not like other types of fish. On the other hand, when the subject of the sentence is focused the inference that other persons in the discourse do not like herring will

be available. Crucially, however, the literal meaning of both sentences remains the same: Carl likes herring in both cases. Further, the exclusive/exhaustive implicature (that the statement does not hold for the alternatives) can be canceled Without contradiction, the discourse could be continued by stating *In fact, Carl likes salmon as well* (if the object was focused). This exhaustive implicature arises through pragmatic reasoning or enrichment procedures (depending on the theory of implicature). Hence, an utterance with bare intonational focus has two readings - a literal reading which does not exclude the alternatives and a pragmatic reading involving an exhaustive inference.

In the case of exclusive particles like *only*, a similar exhaustive inference arises that the alternatives are not true of the utterance. The exclusion of alternatives, however, is part of the conventional meaning of *only*, that is lexically encoded (Rooth, 1992). The sentence with *only* does not have two different readings in the sense described for intonational focus but rather *only* forces the exclusion of alternatives grammatically. In accordance with these theoretical distinctions, experimental work has shown that German participants draw fewer exhaustive inferences from sentences with bare intonational focus than from sentences with *only* (Onea & Beaver, 2011). Yet, the more contrastive the accent on the focused elements is, the more likely it is that participants draw an exhaustive inference even in the case of bare intonational focus (see for example Chevallier *et al.*, 2008 and Gotzner & Spalek, 2014).

Work by Molnár (2002) points to another difference between intonational focus and overt *only* (she looks at Hungarian preverbal focus which is thought of as a semantic exhaustification similar to overt *only*). She proposes a distinction between a weak and a strong exclusion of alternatives and argues that contrastive accents signal that the predication does not hold for at least one other alternative (weak: existential). The focus particle *only*, on the contrary, excludes all other alternatives (strong: universal). Hence, the particle *only* makes a much stronger statement than a contrastive accent, namely that no other alternative than the focused element leads to a true assertion.

In contrast to exclusive particles, additive particles like *also* and *even* presuppose that a statement holds for at least one of the alternatives and express that the proposition holds for the focused element as well (König, 1991). In this

sense the truth of alternative propositions is a pre-condition for a sentence with *also* to be felicitous or at least such a set must be accommodable. It should be noted, however, that this view certainly depends on the theory of presuppositions adopted (for an overview see Schwarz, 2014). What is uncontroversial is that additive focus particles (and exclusives) associate with a focused constituent and that they must refer to a contextually-salient set of alternatives. Hence, independent of the status of the described aspects of meaning (entailment vs. presupposition), for both groups of particles, exclusives and additives, we can derive the hypothesis that the speaker/hearer needs to bear in mind a set of alternatives.

Whereas focus accenting indicates the presence of alternatives, the instantiation of a contextually-salient set of alternatives is a necessary meaning component of focus particles. Hence, we might expect the alternatives to be even more salient in case an utterance contains a particle. We could say that the role of intonational focus is to provide or identify the alternatives and that focus particles make an additional statement about those alternatives. Further, the relation between focus particles and the focused element is conventionalized while it is free in the case of intonational focus (according to Beaver & Clark, 2008).

To summarize, linguistic theory assumes different ways in which the meaning components of focal accents and focus particles are factored into sentence meaning. Focal accents cause an exhaustivity implicature while focus particles affect the truth conditions of a sentence, either by restricting the input to the common ground in terms of a presupposition or by expressing an exhaustive assertion.

2.1.5 Factors influencing the perception of contrast

According to alternative semantics, focus evokes a set of alternatives. There might however be a different extent to which the alternatives are salient contextually and/or in the listener's mind. For example, Calhoun (2009) distinguishes between so-called theoretical "kontrasts" (foci in Rooth's sense) and contrastiveness, taking contrastiveness to represent a speaker intended salient contrast between particular elements (according to Umbach, 2004). Calhoun models the prominence of a word probabilistically according to its expected properties and

position within the metrical structure. She argues that the more prominent than expected a word is the more likely it is contrastive, in the sense that the more salient the alternatives will be to the speaker/listener. Further, increased phonetic prominence (relative to the expected prominence) can force a contrastive reading (Calhoun, 2009, p.11). In a corpus study, Calhoun measured the contrastiveness of a word by looking at how often an alternative was mentioned in preceding or subsequent discourse and observed that not every instance of a theoretical "kontrast" was accompanied by mentioning a set of alternatives in the context. She further found that the realization of the pitch accent on a focused element and how likely an alternative was mentioned depended on a variety of factors, such as the predictability of the word in context and its position in the clause.

An overview article by Repp (2010) discusses a variety of other factors relevant in the definition of contrast itself [3], which might also be relevant for the perceived contrastiveness of an element. For example, the size of the alternative set, whether or not the set is open or closed and possibly how many elements are included in the set might affect how contrastive an utterance is perceived. Repp (2010) notes that focus evokes a set of alternatives but this set may remain implicit - it does not need to be listed contextually and it can be accommodated. Further the elements of the set do not need to be identifiable. Contrastive focus (according to Kiss (1998)'s notion of exhaustive focus) might, on the other hand, have a requirement to exclude alternatives that are explicitly mentioned or identifiable (and restricted). Here, contrastive focus is understood in the sense that what is said about the focused element is not true of the alternatives. Focus (as evoking alternatives), on the other hand, does not have this requirement but as we have seen in the previous section the exclusion of alternatives might arise by pragmatic strengthening.

In line with the proposal made in Rooth (1985, 1992) no further distinction between focus and contrastive focus is made in this dissertation. I assume that the function of focus is to evoke a set of alternatives. However, the factors just

[3]The original purpose of the paper was to investigate whether contrast might constitute an information-structural category on its own, independent of focus and topic, as is for example assumed by Molnár (2002) (see also Repp, to appear).

discussed might affect how contrastive a word is perceived, that is how salient the alternatives are to the listener. I further assume that the exclusion of alternatives might arise pragmatically in certain contexts but is not part of the semantics of intonational focus.

2.2 Previous psycholinguistic evidence

In Section 2.2., I first provide a brief overview of previous studies that investigated the representation and processing of focal information. I will then present two accounts of the role of focus in long-term representations that were contrasted in a study by Fraundorf *et al.* (2010). Based on the study by Fraundorf *et al.* (2010), I will explore the hypothesis that focus changes the representation of focus alternatives. The second part of this section looks at how the set of alternatives emerges, reviewing previous online studies that manipulated contrastive accenting and focus particles. I will finally sketch two possible accounts of how the set of alternatives is established over the course of time and how it is ultimately represented in a listener's long-term memory.

2.2.1 Focal information in language processing and memory

2.2.1.1 Focus and online sentence processing

In the theoretical section, it has become clear that information structure guides communication and reflects the beliefs and intentions of the speaker. If the focus structure of a sentence successfully reflects the intention of the speaker, then it necessarily has consequences for how a sentence is processed and perceived by the hearer.

Cutler & Fodor (1979) were among the first to show that the focus structure of an utterance guides the listener's attention in language processing. The underlying conception of focus in their study was that focused information is prosodically prominent and possibly informationally important (in this section the term focus is used more loosely as indicating new, contrastive or important information). In a phoneme monitoring experiment, the authors tested participants' ability to

recognize a phoneme depending on whether it occurred in a focal or non-focal word. Cutler & Fodor (1979) reason that accents often mark sentential focus and thereby highlight new or important information, leading to increased attention. They manipulate focus with question-answer pairs that either put focus on the subject or object of the sentence (*Which man was wearing the hat?* vs. *What hat was the man wearing?*). The phoneme target either appeared in subject or object position of the sentence (e.g., /k/ and /b/ in the answer sentence *[The man on the corner]$_S$ was wearing [the blue hat]$_O$*) and the acoustic parameters were held constant across conditions. The results revealed that participants detected the phoneme best when the target position in the answer sentence corresponded to focus position specified by the question. Therefore, Cutler & Fodor (1976) concluded that listeners devote their attention to focal information and rely on it when parsing a sentence.

A great number of following studies have investigated the role of focus in sentence processing and comprehension. A variety of areas in sentence processing have been shown to be influenced by the focus structure of an utterance. During silent reading, focus affects both the time spent to read a word as well as regressive eye movements (e.g., Birch & Rayner, 1995; Birch & Rayner, 2010; Morris & Folk, 1998; Ward & Sturt, 2007). Focus structure guides ambiguity resolution, ellipsis processing and referent identification (e.g., Almor, 1999; Almor & Eimas, 2008; Klin *et al.*, 2004; Foraker & McElree, 2007; Carlson *et al.*, 2009). In addition, focus affects production choices (e.g, Cowles, 2003; Kaiser, 2011).[4]

These previous studies indicate that focus structure might guide sentence processing by highlighting new or important information and distressing given or backgrounded information. Most of the early work on focus was interested in the processing/representation of focal information itself but not so much in the representation of focus alternatives. From some of those online studies, the hypothesis can be formulated that focus has primarily a role in the identification

[4]Since this dissertation is concerned with mnemonic effects of focus on alternatives and the evolving representation of the alternative set, I will not present a detailed overview of online studies on the representation of focal information itself. I refer the reader to overview articles by Carlson *et al.*, 2009 and Cowles, 2012.

of constituents. In fact, such an identification account of focus has been proposed by Almor & Eimas (2008) (see Fraundorf *et al.*, 2010 for a detailed discussion).

2.2.1.2 Memory for focal information and focus alternatives

Apart from a role in referent identification, focus might also alter the representation of a discourse more profoundly. A study by Fraundorf *et al.* (2010) contrasted two accounts of the mnemonic effects of focus, which are relevant for this thesis. The so-called granularity account by Sanford *et al.* (2006) assumes that focus leads to a more fine-grained representation of an event, enhancing specifically the representation of the focused element and leading to a more shallow processing of non-focal information. The contrast representation account proposed by Fraundorf *et al.* (2010), on the other hand, assumes that all members of a contrast set (e.g., when a set of elements is listed in the context) are better encoded due to focus marking. That is, focus should enhance memory for the focused element itself as well as for focus alternatives.

The granularity account was developed in Sanford *et al.* (2006). The authors used a change-detection paradigm to explore with what level of semantic depth different parts of a text are processed. Participants listened to short auditory discourses twice and were asked to indicate whether a word had changed between the first and second presentations. The manipulation was whether the changed word appeared in a broad or narrow focus condition. In the narrow focus condition, the first sentence put focus on the target item by an implicit question (*They wanted to find out which money had been stolen*) and the target item was spoken with a contrastive accent (*The money from the [wallet]$_F$ had gone missing*). In the broad focus condition, the discourse established a broad question (*They wanted to find out what had happened*) and the target word *wallet* was spoken with a non-contrastive accent. The target word was changed either to an item of the same semantic category (from *wallet* to *purse*) or a different category (*bank*).

The results showed that participants were better at detecting the change in the narrow focus condition than in the broad focus condition. Moreover, the difference between the focus conditions was larger when the changed target word was of the same semantic category compared to a different category item. Sanford

et al. (2006) therefore propose that the role of focus is to increase the semantic specificity of a representation leading to better change detection. The idea is that listeners encode an item at a superordinate level when it is not focused or in broad focus. For example, they represent *wallet* as an accessory, which would be insufficient for detecting the change to purse. In the narrow focus, they in turn represent the concept *wallet* more specifically (at the subordinate level) leading to better change detection.

According to the granularity account, focus specifically strengthens the representation of a focused element, decreasing the activation of within-category items (alternatives). Between-category changes (*wallet-bank*) can be detected independent of the specificity/granularity level with which the focused element (*wallet*) is represented, therefore the effect of focus was smaller in this condition. Overall, the study by Sanford and colleagues indicates that focus not only plays a role in referent identification and online processing (as suggested by Almor & Eimas, 2008) but also affects long-term representations of an event.

A number of other studies have shown that focused elements are remembered better than non-focused elements and are represented with more semantic detail (e.g., Osaka *et al.*, 2002; Sturt *et al.*, 2004; Ward & Sturt, 2007; Sanford *et al.*, 2009). All those data are consistent with the granularity account, but they equally do not rule out the contrast representation account advocated by Fraundorf *et al.* (2010).

Fraundorf *et al.* (2010) reason that linguistic focus should not only benefit the representation of the focused element but also that of alternatives to the focused expression, in line with an alternative semantic account of focus. In their study, Fraundorf and colleagues directly pit the granularity and the contrast representation account against each other. According to the granularity account, focus should lead to less activation of semantic alternatives and it should affect any item of the same semantic category, even unmentioned alternatives. Critically, the granularity account assumes that any effects of focus manipulations result from the fact that the focused element itself is encoded at a more fine-grained level. The contrast representation account, in turn, predicts that all items in a contextual contrast set should be encoded more richly. Other items of the same

category (e.g., unmentioned alternatives), not included in a contextual contrast set should, however, not be affected by linguistic focus on this account.

Fraundorf *et al.* (2010) provided the first clear evidence that focus enhances the long-term representations of focal information as well as that of explicit alternatives, favoring a contrast representation account. They compared non-contrastive (H*) and contrastive (L+H*) pitch accents in discourses that contained a contrast set with two elements (e.g., French and British scientists). The first two experiments presented all items in a row and subsequently tested recognition memory with a two-alternative forced choice task. Experiment 1 and 2 found that the L+H* accent facilitated the recognition of the accented items and that this was not due to the effect that the other parts of the discourse were impaired. In Experiment 3, the authors introduced a truth-value judgment task to investigate the hypothesis that the L+H* accent facilitates encoding of the whole contrast set but not of elements that were not mentioned in the discourses (so-called lures or unmentioned alternatives). In the recognition phase, which took place one day after participants had been exposed to the stimuli, participants had to indicate whether a statement was true or false. For example, if the critical sentence was *The [British]$_F$ spotted the monkeys*, participants judged whether the statement *The French spotted the monkeys* (mentioned alternative) was true. The results of Experiment 3 indicated that the L+H* accent increased both the number of hits to correct statements and the number of correct rejections of the contrast item. The rejection of lures (e.g., *The Portuguese spotted the monkeys*), however, was unaffected. According to the contrast representation account advocated by Fraundorf *et al.* (2010) listeners use contrastive pitch accents to encode the whole contrast set more richly and to represent information that did not happen.

The study by Fraundorf and colleagues provides evidence that information about focus alternatives is encoded and stored in a listener's long-term memory when it was highlighted by a contrastive pitch accent. Chapter 3 of this thesis establishes that focus particles lead to better encoding of focus alternatives as well. The remainder of the thesis is concerned with the mechanisms by which this representation evolves. I will, therefore, turn to online studies subsequently.

2.2.2 Alternatives in online processing

2.2.2.1 Pitch accents in cross-modal priming paradigms

As was just outlined, one prior memory study showed an effect of intonational focus on memory for focus alternatives. A couple of recent online studies have provided evidence that contrastive pitch accents create a representation of contrastive alternatives and reveal how the set of alternatives is further processed.[6]

Braun & Tagliapietra (2010) used a cross-modal priming paradigm to investigate whether contrastive pitch accents activate alternatives (building on an earlier study by Norris *et al.*, 2006). Participants were presented with sentences that contained a double contrast (*Our [neighbors]$_F$ assembled an [antenna]$_F$*) and had to perform a lexical decision task on a target (DISH) that appeared after they heard the sentences. The sentence final prime word (*antenna*) was either spoken with an H* accent or a contrastive L+H* accent. In Experiment 1a, participants saw target words that were contrastively-associated with the critical primes (e.g., prime: *antenna*, target: DISH) or unrelated to the control primes (e.g., prime: *trapeze*, target: DISH). The results showed that the L+H* accent facilitated the recognition of the contrastively-related targets relative to the unrelated primes (e.g., the contrastively-accented noun antenna primed the target DISH). With the non-contrastive intonational contour (H*), in turn, no significant priming effect was observed: the targets were recognized equally fast with contrastive and unrelated primes.

In Experiment 1b, subjects were exposed to the same stimuli but saw non-contrastively associated targets to the critical primes (e.g., prime: *antenna* and target: TELEVISION). Those target words were associated with the critical primes by general world knowledge but could not replace them, that is, they were no alternatives to the focused elements. The results revealed a slight overall priming effect for non-contrastive targets such that these items were recognized faster in the related (non-contrastively associated) than unrelated prime conditions. Crucially, however, no interaction between prosodic conditions and relatedness was found. In other words, the priming of non-contrastive associates was the same in the condition with contrastive accenting and neutral accenting.

[6]The following sections are part of the introduction to Gotzner *et al.* (2016).

In summary, Braun & Tagliapietra (2010) revealed that contrastive intonational contours lead to the activation of contrastive associates (i.e., alternatives) while non-contrastive prosody did not cause such an effect. In addition, they found an overall priming effect of non-contrastive associates, which was of the same magnitude with contrastive and non-contrastive intonation.

Husband & Ferreira (2016) followed up on Braun & Tagliapietra (2010) and investigated how alternative sets evolve over the course of time. They compared the activation of contrastive and non-contrastive associates to a prime word across two stimulus onset asynchronies (SOA). Participants were exposed to auditory stimuli that either contained an H* or an L+H* accent on the prime word (e.g., *The museum thrilled the [sculptor]$_F$ when they called about his work*). At the offset of the prime word *sculptor*, while the sentence was being played, a visual target appeared on the screen that was either contrastively-associated (e.g., PAINTER), non-contrastively-associated (STATUE) or unrelated to the prime (REGISTER). In the first experiment, the targets appeared at an SOA of 0 ms. The results showed that contrastive targets were facilitated compared to unrelated targets in both contexts - with neutral and contrastively-accented primes. The non-contrastive targets were only primed if the prime word was contrastively-stressed. Husband & Ferreira (2016) assume that the lack of priming for non-contrastive targets in the neutral contexts is due to temporal aspects (slower activation in the neutral condition) and argue that contrastively-focused words initially prime both contrastive and non-contrastive meanings.

In the second experiment, the targets were presented at an SOA of 750 ms. It was found that contrastive targets were again facilitated, independent of whether the primes received neutral or contrastive prosody. Non-contrastive targets, however, were only primed in case the primes were pronounced with an H* accent but not with L+H* accent. Hence, if a prime is contrastively-accented only contrastive associates to the prime word continue to be facilitated. The authors conclude that this effect indicates that the contrastive-associates are considered as part of the alternative set.

Husband and Ferreira propose a mechanism of establishing alternative sets involving initial activation of all associates to a focused expression and later selection of the contrastive associates, that is, the proper alternatives. According

to their view, non-contrastive words are primed due to their association with the focused element and need to be rejected/suppressed in a later step, either by activation decay or a more active mechanism of suppression. Thus, initially activation flows to all associates of a focused word and the alternatives are then selected in a subsequent step. Husband and Ferreira conclude that the resolution of alternative sets in online language comprehension requires time and note that comprehenders might engage in different strategies to establish a set of alternatives depending on how focus is marked (e.g., by focus particles, syntactic means or prosodically).

There are two apparent differences between the results of Braun & Tagliapietra (2010) and Husband & Ferreira (2016). First, while Braun & Tagliapietra (2010) only found a priming effect of contrastive associates when the intonation was contrastive, Husband & Ferreira (2016) found a priming effect in both prosodic conditions, contrastive and non-contrastive, (which disappeared in the neutral prosodic condition at the 750 ms SOA). In addition, the magnitude of the priming effect in Husband & Ferreira (2016) was the same in both prosodic conditions. Secondly, in Braun & Tagliapietra (2010), there were no differences across prosodic conditions when participants recognized non-contrastively associated target words. Husband & Ferreira (2016), on the other hand, found that non-contrastive targets were not facilitated in the neutral accenting condition at an SOA of 0 ms but facilitated at the later SOA. But more importantly at an interpretational level Braun & Tagliapietra (2010) suggest that non-contrastive targets should not be differentially affected by prosody and that only contrastive accents should activate alternatives (or at least the priming effect should be stronger than in the neutral prosodic condition). Husband & Ferreira (2016), on the contrary, propose that, initially, both contrastive and non-contrastive targets become activated in contrastive and neutral prosodic conditions. The crucial difference is then that the contrastive alternatives maintain facilitation only if they were highlighted by a contrastive accent. In sum, this might suggest that a part of the mechanisms of focus is to suppress non-contrastive meanings on Husband and Ferreira's account while Braun & Tagliapietra (2010) do not reserve any special function of focus on the representation of non-contrastive elements.

Braun & Tagliapietra (2010) did not employ the SOA manipulation and there are methodological differences between the two studies that might contribute to these differential results (e.g., position of the prime word, double contrast intonation vs. single contrast). So far, we cannot decide whether focus primarily affects the representation of contrastive elements or whether non-contrastive elements also play a particular role, but I will address this question in Chapter 5.

In summary, the priming studies by Braun & Tagliapietra (2010) and Husband & Ferreira (2016) provide evidence that after having processed a sentence with a contrastive intonation contour, a noun that can replace the prime word is more accessible. Hence, the studies show that contrastive pitch accents create a representation of alternatives to the accented element in online language processing. It should be kept in mind that in these experiments, the alternatives were not mentioned in the context sentence. The next section will look at previous studies which investigated the impact of focus particles on online processing of alternatives.

2.2.2.2 Online studies with focus particles

During the preparation of this thesis, two other related doctoral dissertations on focus particles and alternatives in online processing have been submitted, Kim (2012) and Byram-Washburn (2013). Kim (2012)'s dissertation investigates a range of contextual factors that might influence the construction of alternative sets in online processing. The experiments employed a visual world paradigm with auditory instructions to find out how the online interpretation of focus operators unfolds with time and how it interacts with the preceding context.

In Experiment 1, participants were presented with auditory discourses that either contained the particle *only* or not (e.g., *Mark has some candy and apples. Jane only/_ has some [oranges]$_F$*). While listening to the discourses, participants were presented with a visual display containing four items and were asked to click on the item Jane has (second character in critical sentence). The visual display contained the target item (a picture of oranges), a cohort competitor with the same phonological onset (a picture of oars) and two unrelated distractor items (pictures of pencils and mittens in the given example). What Kim found is that

participants were faster at disambiguating the target from the cohort competitor when the discourses contained the particle *only* compared to no particle. This finding indicates that participants were using the semantic alternative mentioned in the context sentences (*apples*) to predict the upcoming focused element in case they encountered the particle *only*.

In another experiment, Kim (2012) compared the lexical contributions of the particles *only* and *also* in contexts where the focused element was either mentioned in the first sentence or novel (but of the same semantic category). The eye gaze patterns showed that *only* and *also* elicit different expectations concerning the upcoming referents: Whereas participants were more likely to fixate a subset member of a semantic category (e.g., apples from the category fruit) in the case of *only*, they were more likely to fixate the superset of a category (a picture with different kinds of fruit) in the case of *also*. Kim attributes these findings to the meaning differences among the two groups of particles. She concludes that listeners keep track of the discourse status of an entity (old/new) and use this information to identify the alternatives required to interpret upcoming focus expressions.

Overall, the experiments by Kim (2012) show that a variety of contextual variables play a role in the interpretation of focus particles (see also the four further experiments in her thesis) and they provide implicit evidence that listeners activate a set of alternatives, when they process such particles. Note, that the visual world paradigm by Kim measures the activation or expectedness of the focused element given a set of alternatives, that is, before participants actually know what the focused element is. The effect that the particle *only* led to a faster detection of the focused element (e.g., in the first experiment) might rely on two possible mechanisms: (i) alternatives became activated to predict the focused element and/or (ii) the alternatives were inhibited in favor of the upcoming focused element. Note also that both of these mechanisms might play a role (see below).

Byram-Washburn (2013) investigated the impact of focus particles on the retrieval of alternatives. The overall goal of her dissertation was to find out which definition of focus is adequate and whether different types of foci such as new information focus and contrastive focus access alternatives. The first two experiments of Byram-Washburn's thesis employed a lexical decision paradigm. In

Experiment 1, she presented participants with written discourses that introduced a set of three elements (e.g., *Christina wants to buy a lock, nails and a bolt*). The set consisted of elements that were semantic associates (*lock* and *bolt*) and an item that was introduced as a novel associate (*nails*) in the set by virtue of being mentioned together. The critical sentences appeared in one of three different prime type conditions, a contrastive associate, a novel associate or an unrelated prime. Focus was either marked by the particle *only* or unmarked (*At the store, she was able to buy only/_ [nails]$_F$/a [bolt]$_F$/a [lamp]$_F$*). Since the discourses were presented visually, the focus particle was the only focus marker (there was no intonational focus marking). Participants hit a space bar if they had finished reading the sentences and at a delay of 250 ms, the target word appeared on the screen (LOCK in all conditions).

The results revealed that the targets were recognized faster in the conditions with *only* than without a particle when the prime word was a novel associate (*nails*) but not when it was a semantic associate (i.e., a mentioned alternative, *lock*). Byram-Washburn (2013) reasons that the lack of effects for the semantic associates might be due to power reasons or that the members of the alternative set might be made less salient or in other words inhibited. From the effect of focus on the novel associates, she concludes that speakers use contextual information to build alternative sets and do not solely rely on previously-existing semantic networks.

In a second lexical decision experiment, Byram-Washburn used spoken stimuli and found that participants were slower at recognizing a target word in a condition with *only* compared to a condition where the prime words were de-accented. A condition with a contrastive accent did not differ from the other two conditions. Overall, the dissertation by Byram-Washburn provides some evidence that focus particles and contrastive focal accents inhibit alternatives (an inhibition of the alternatives by contrastive accents was found in a mouse tracking experiment) and there was also evidence that focus particles facilitate newly-learned associates. Hence, it is currently unclear whether and under which circumstances focus alternatives are activated, inhibited or both.

2.3 Summary of previous evidence

Braun & Tagliapietra (2010) and Husband & Ferreira (2016) showed that contrastive accents immediately activate alternatives which is in line with the assumption that (i) focus evokes a set of alternatives and (ii) that the more prominent an accent is the more salient the alternatives are to the listener. The first lexical decision study by Byram-Washburn (2013) provided evidence that the particle *only* facilitated newly-associated alternatives but not mentioned semantic alternatives. In her second lexical decision experiment and in an additional mouse tracking experiment Byram-Washburn (2013), in turn, found that contrastive accents as well as focus particles inhibited alternatives.[7] The data presented in these previous studies seem contradictory at first glance. However, it should be noted that in Byram-Washburn's first experiment, the discourses were presented in written. Therefore, the particle *only* was the sole focus marker. Furthermore, it might be that compiling a set of alternatives relies on both mechanisms, activation and inhibition (see especially Chapter 4). Husband & Ferreira (2016) proposed that focus activates semantic alternatives and inhibits non-contrastive associates. The study also showed that timing is a crucial factor. Byram-Washburn (2013), in her final discussion, further considers the possibility that semantic alternatives might be both facilitated and inhibited. Looking at the results of Braun & Tagliapietra (2010) and Husband & Ferreira (2016), it seems that contrastive accents consistently facilitated unmentioned alternatives at an SOA of 0 ms. This is in line with the assumption that the function of focus is to introduce alternatives. Note that in these studies, no alternative set was listed in the context. The mouse-tracking study by Byram-Washburn (2013) found inhibition of unmentioned alternatives by contrastive accents at a later offset. For focus particles, however, the evidence was less consistent. The first lexical decision study by Byram-Washburn (2013) found a facilitation of newly-learned associates while mentioned semantic alternatives were neither facilitated nor inhibited. Experiment 2 instead found an inhibition of the mentioned semantic alternatives, the most striking difference

[7] Though the effect of the contrastive accent was not significant in the lexical decision study (but in the mouse tracking experiment).

between the experiments being that the stimuli were presented auditory in Experiment 2 and visually in Experiment 1 (however further aspects of the design were changed as well). Hence, the specific contribution of intonational focus and focus particles on the retrieval of alternatives is currently unclear.

In the next chapter, I will examine the impact of focus particles on later representations of the alternative set. Chapter 4 is devoted to investigating the mechanisms of activation and inhibition. Chapter 5 explores which elements are considered as alternatives while Chapter 6 directly compares the impact of contrastive pitch accents and focus particles on the representation of alternatives. Finally, Chapter 7 provides an overview of all experimental findings concerning the retrieval of alternatives and presents the conclusions of this dissertation.

Chapter 3

Long-term representation of the entire alternative set

Previous research has shown that focus structure guides the listener's attention leading to more detailed memory for focused elements. Some of the experiments outlined in the previous chapter indicated that the effect of focus might not only privilege the focused element itself but also improve memory for alternatives to the focused element (in particular Fraundorf *et al.*, 2010). The first two experiments of this thesis test whether focus particles have an impact on long-term representations of contextually-provided alternatives.[1]

3.1 Specific hypotheses: Lexical meaning or focus association?

Fraundorf *et al.* (2010) have shown that contrastive focal accents enhance the representation of focus alternatives. In the following experiments of this dissertation, we compare experimental conditions that contain a focus accent and either an exclusive particle, an additive particle or no particle (as a control). Why would we expect an effect of focus particles if focus alone already introduces a set of

[1] Chapter 3 is based on Spalek *et al.* (2014) with some modifications. The experiments were designed by Katharina Spalek and Nicole Gotzner and both authors wrote the article. Nicole Gotzner prepared and recorded the stimuli and analyzed all data.

alternatives? Whereas focus accenting indicates the presence of alternatives, the instantiation of a contextually-salient set of alternatives is a necessary meaning component of focus particles. Therefore, we might expect the alternatives to become even more salient in case an utterance contains a particle compared to bare focal intonation.

As described in Chapter 2, linguistic theory divides focus particles into groups according to their specific meaning components. Exclusives like *only* express that the alternatives do not hold while additives such as *even* and *also* presuppose the truth of alternative propositions. From this distinction, it might follow that the alternatives are mentally switched off if an exclusive particle is used while they become more salient in the case of inclusive particles. This hypothesis will be referred to as the lexical meaning hypothesis. The lexical meaning hypothesis predicts that exclusive and inclusive particles should differentially affect the representation of alternatives since the different groups of particles have different meaning components - exclusive or inclusive.

However, there is an alternative possibility. Since both exclusives and additives encode a set of alternatives in their semantic definition, it might be that the representation of the alternatives is enhanced overall. In other words, for both exclusives and additives we can derive the hypothesis that the speaker/hearer needs to bear in mind a set of alternatives in their mental model upon encountering a focus particle. For this reason, memory for the alternatives might be facilitated by exclusives as well as additives. I will refer to this hypothesis as the focus association hypothesis[2], which predicts similar effects for both particles.

[2]In Spalek *et al.* (2014), we called this hypothesis the *contrast hypothesis*. However, since I do not assume that focused elements genuinely contrast with the alternatives (in the sense that the alternatives have to be negated) the term was relabeled here (see the discussion in Chapter 2).

3.2 Experiment 1a: Salience of alternatives in long-term memory

3.2.1 Goals and predictions

Experiment 1a employs a delayed recall paradigm to investigate the impact of focus particles on long-term memory for focus alternatives. Participants were exposed to discourses that introduced sets of three elements and specified one of the elements carrying intonational focus in the critical sentences in all conditions. The manipulation was whether the critical sentences contained the exclusive particle *only*, the inclusive scalar particle *even* or no particle as a control condition. In the test phase, participants had to recall the elements mentioned in the context sentences after a delay of about 4 minutes. The measure of interest was the number of recalled alternatives to the focused element (the element mentioned in the critical sentences).

According to the lexical meaning hypothesis outlined above, memory for the alternative set should be worst for exclusives, intermediate in the control condition and best for inclusives. Since the particle *only* excludes the alternatives, it might be that participants forget about the alternatives more easily because they are not true of the sentence. The particle *even* expresses that alternatives to the focused element were also true of the sentence. Therefore, participants might recall the alternatives better if *even* was used.

Alternatively, the focus association hypothesis predicts that both conditions with focus operators lead to better memory for the alternative set, compared to the control condition without a focus particle due to the fact that both particles require a salient set of alternatives.

3.2.2 Method

3.2.2.1 Participants

Twenty-six native speakers of German (21 female, five male, mean age 27.1 years, SD 3.8, age range 22-31) were recruited from the subject pool at the Institute of Psychology of Humboldt University and paid seven Euros in compensation. None

of them reported any vision or hearing difficulties. The data of two subjects were excluded from the analysis due to technical problems. The remaining participants were 19 women and five men with a mean age of 27.4.

3.2.2.2 Apparatus

Participants were seated in a darkened room in front of an Acer TFT monitor (type Asus 1923d) with a resolution of 1280 × 1024 and a refresh rate of 75 Hz (13.3 ms). Stimulus presentation was controlled by Neurobehavioral Systems' Presentation software (Version 15.1). Subjects wore Sennheiser headphones with an integrated microphone. Answers in the test sessions were recorded as wav-files. The apparatus was the same in all following experiments of this thesis, therefore it is only reported once in this chapter.

3.2.2.3 Materials

Participants listened to 50 pre-recorded dialogs containing two context sentences and a critical sentence (a list of all items can be found in Appendix A.1). The context sentences introduced a set of three elements, a person, and an assumption about a particular event referring to the previously mentioned entities (see (1) below). The critical sentence was spoken by a different speaker and revised the assumption of the first speaker. The purpose of choosing this particular structure of the dialogs was to introduce the additive presupposition of *even* and to mention all elements equally often. By mentioning all elements twice, we could make sure that any differences across conditions or between the focused elements and its alternatives were not simply due to differences in mention.

The context and continuation sentences were recorded by a male speaker and the critical sentences were spoken by myself with special attention to producing similar prosodic contours across conditions. Both speakers had a middle German accent close to the standard variety of German and recording took place in a sound proof room. For the critical sentence, three versions were recorded: it either contained (a) the exclusive particle *nur* ('only'), (b) the inclusive particle *sogar* ('even'), or (c) no focus operator as a control condition. In the experiment, one of these three versions was randomly assigned to a given experimental

list (i.e., neither context sentences nor critical sentences were repeated within participants). Example (1) shows an example item.

(1) **Context sentence (speaker 1):**
In der Obstschüssel liegen Pfirsiche, Kirschen und Bananen
'In the fruit bowl, there are peaches, cherries, and bananas'
Continuation sentence (speaker 1):
Ich wette, Carsten hat Kirschen und Bananen gegessen
'I bet Carsten ate cherries and bananas'
Critical sentences (speaker 2):
(a) Nein, er hat nur [Pfirsiche]$_{\text{F}}$ gegessen
(b) Nein, er sogar [Pfirsiche]$_{\text{F}}$ gegessen
(c) Nein, er hat [Pfirsiche]$_{\text{F}}$ gegessen
'No, he (a) only/(b) even/(c)$_{\_}$ ate [peaches]$_{\text{F}}$'

The three elements given in the context sentences were presented in random order (randomization was performed with a random numbers function in Excel). The second sentence was spoken with a pitch accent on the two elements (in example (1): *cherries, bananas*). In the critical sentences, the third element which had not been mentioned in the second context sentence appeared as the focused element (in example (1): *peaches*), thereby ensuring that each element was mentioned twice in the dialogue. Which element of the first context sentence (first, second or third) was focused in the critical sentence, was counterbalanced across items.

The critical sentences with particles were pronounced with a hat contour (see Féry, 1993), having a pitch accent on the focus particle as well as the focused element and the condition without a particle had a falling pitch accent on the focused constituent. Figure 3.1 displays the mean pitch contours of the focused element for the three experimental conditions. Importantly, the accent type was the same across conditions, as can be seen from the figure.

Acoustic analyses were conducted on the focused element to assess whether there were prosodic differences across conditions. Table 3.1 presents means and standard errors for duration, maximum pitch, minimum pitch, difference between maximum and minimum pitch, mean pitch, and the relative points of maximum

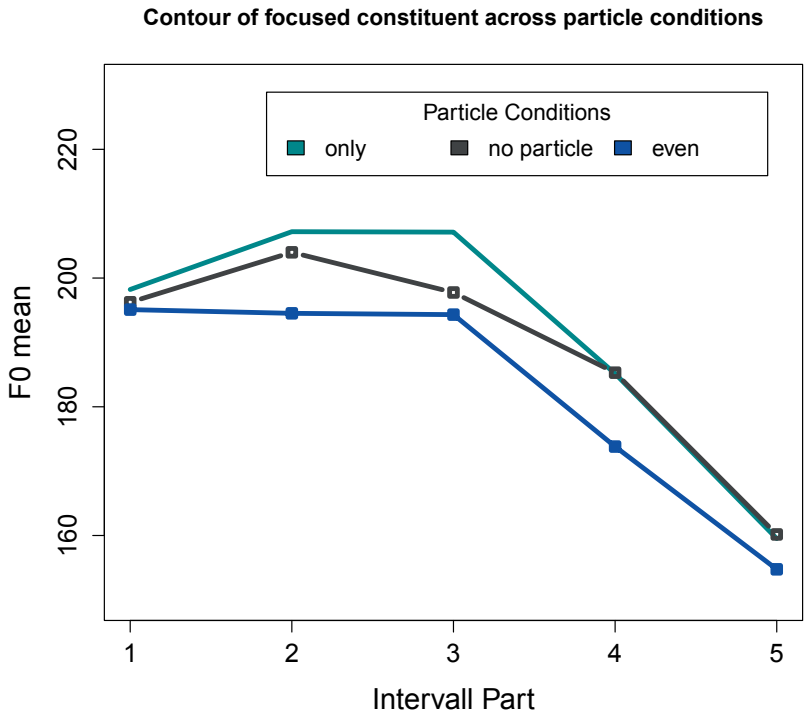

Figure 3.1: Mean pitch contour of the focused element in Experiment 1a

and minimum pitch for both the stressed syllable and the entire word. The focused elements of the three conditions did not differ significantly on those parameters except for the mean pitch of the stressed syllable and the entire word and the point of pitch maximum of the entire word.

Table 3.1: Mean acoustic parameters of the focused element in the critical sentences (e.g., *Pfirsiche* in (1)).

Measure	***Only***		**No particle**		***Even***		**F**	**p**
	Mean	SE	Mean	SE	Mean	SE		
Stressed syllable								
Duration (s)	0.24	0.01	0.23	0.01	0.23	0.01	<1	0.77
Max pitch (Hz)	213	2.53	225	8	207	7.63	<1	0.58
Min pitch (Hz)	194	2.29	197	4.38	185	3.85	<1	0.37
Pitch diff.	20	1.7	28	8.49	22	5.59	<1	0.58
Mean pitch (Hz)	203	2.18	210	3.93	195	4.53	11.58	0.0001
Point of max (s)	0.15	0.01	0.13	0.01	0.12	0.01	<1	0.67
Point of min (s)	0.16	0.02	0.16	0.02	0.18	0.02	1.52	0.23
Entire word								
Duration (s)	0.49	0.02	0.49	0.02	0.49	0.01	<1	0.87
Max pitch (Hz)	225	8	222	8.12	212	6.66	2.5	0.85
Min pitch (Hz)	148	2.46	148	2.94	145	3.03	7.43	0.1
Pitch diff.	78	8.4	74	7.8	67	6.74	<1	0.56
Mean pitch (Hz)	189	1.65	186	1.74	179	2.37	7.87	0.0001
Point of max (s)	0.15	0.02	0.17	0.02	0.16	0.02	2.26	0.01
Point of min (s)	0.46	0.02	0.46	0.01	0.43	0.02	<1	0.38

For the construction of each of the 30 experimental items, a unique setting was chosen (for example the fruit bowl was used only in one item) and 90 German high frequency nouns (more than one occurrence per million according to the DLEX database, Heister *et al.*, 2011) from taxonomic categories served as the list of elements (see Schröder *et al.*, 2012, for the category norms). In each item, there were three nouns and the number of syllables was kept as constant

as possible within an item. For the second context sentence, 23 common German verbs (normalized type frequency range: 1-68) were used that described simple actions (some verbs like *einkaufen* ('to buy' were used twice) and 30 German names (male and female).

In addition to the experimental items, a set of 20 filler items was constructed in order to discourage participants from concentrating only on the list of elements. The fillers had exactly the same structure as the experimental items and the elements chosen were from various categories (either taxonomic or non-taxonomic). The critical sentences of the filler items were also recorded in three versions and participants only saw one of the conditions in the experiment.

Participants listened to ten items in a row, comprised of filler and experimental items. After that, they were presented with questions about these items (see also the Procedure section). For the experimental items, participants were asked to recall the list of elements. The critical question always mentioned the category and the setting, e.g., *Which fruits were in the fruit bowl?* for example (1). For the filler items, comprehension questions were presented to make sure that participants listened carefully to the entire dialog, not just to the nouns mentioned in the first context sentence. The filler questions either asked about the setting, the name of the protagonist, the action, or the focus particle. A question about the focus particle was always posed in such a way that the answer could be determined easily, e.g., the question *Did Carsten eat bananas and cherries?* requires a no-response in the context of example (1) (*No, he only ate peaches*).[3]

In total, we constructed a set of 60 filler questions: 21 about the action, 19 about the setting, five about the person, and 15 about the focus particle. A participant received 20 of those questions chosen randomly from three different lists.

Each participant was exposed to all 30 experimental items and 20 filler items in five blocks of ten items containing different particle conditions. The conditions were rotated across items according to a Latin Square Design, so that one subject

[3]Note that in the case of a sentence without focus particle this question is possibly indeterminate, since this is not explicitly stated by the sentence. We avoided these kinds of questions in order not to confuse participants. An example question about the particle *even* is *Did Carsten eat several kinds of fruits?*, requiring a yes response.

heard an item only once in a particular condition. This resulted in a total of three lists that were pseudo-randomized for each participant. For randomization, the program Mix (van Casteren & Davis, 2006) was used with the following constraints: no more than three filler or experimental items were presented in a row, a particular particle condition (*only*, *even*, no particle) appeared at most twice in a row and, within a block, a category (e.g., fruit) appeared only once to control for interference effects from similar categories.

3.2.2.4 Procedure

The experiment started with an on-screen-instruction informing participants about the structure of the experiment and the task they would have to perform. The instruction explained the structure of the dialogs and told the participants that they would be asked later to recall details about the stories. Subjects were told that, during the test phase, they would only have a limited time frame to respond and that they were supposed to respond aloud. After the instructions were displayed, subjects performed four practice trials (a block of four dialogs followed by four questions) and were allowed to adjust the sound volume of the headphones.

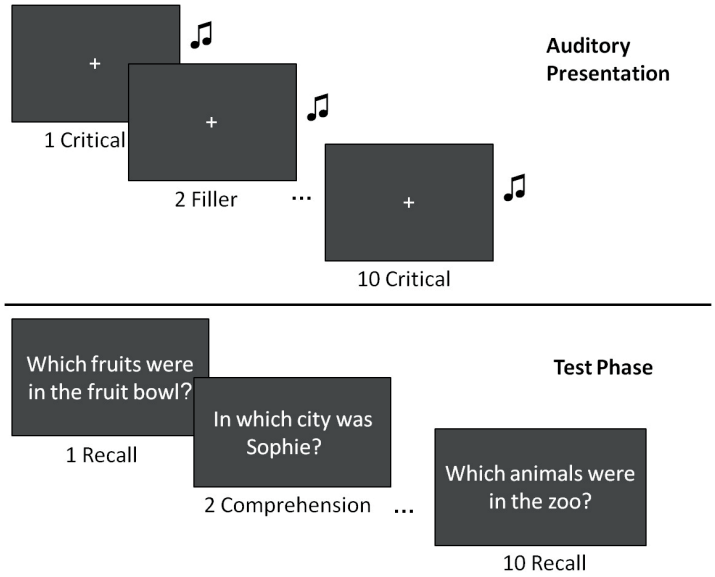

Figure 3.2: Trial sequence: Delayed recall

The structure of one experimental block is exemplified in Fig. 3.2. Phases of auditory discourse presentation alternated with test phases in which participants were cued for recall. In the auditory presentation phase, each trial began with the onset of a central fixation cross displayed for 500 ms. Then, a three sentence discourse item was presented over headphones. The next trial was immediately initiated by a fixation cross. After a block of ten trials (lasting approximately four minutes), the recall phase was initiated by a self-paced button press.

In the recall phase, a trial again started with a fixation cross shown for 500 ms, then the question appeared on the screen for three s, followed by an asterisk that was displayed for 650 ms. Subjects were supposed to respond orally as soon as the asterisk appeared on the screen. Responses were recorded, and participants had 14 s to respond. In order not to loose information if a participant responded too early (i.e., while the question was still on the screen), recordings actually started from the onset of the question and lasted 17 s. Immediately after recording, the subsequent trial was initiated by a fixation cross and the next question was displayed on the screen. All items were tested in the same order as presented during the presentation phase. Thus, the amount of delay between presentation and test was kept constant and subjects could easily keep track of the sequence.

At the end of a block (i.e., auditory presentation phase and recall phase, see Fig. 3.2), subjects were asked to perform a simple n-backward counting task progressing from two to six increments and to take a small break. This was done to reduce interference effects between blocks, because some categories were used more than once (but only once within a given block). The experiment had five experimental blocks. After the experiment, a questionnaire was administered asking the participant for basic demographic information, what he or she thought the experiment was about and whether he or she employed any specific strategies. An entire testing session lasted about 40 minutes.

3.2.3 Results

The recorded answers were transcribed and the number of correct responses was calculated. If a subject mentioned a variant of the presented nouns (e.g. *handbag* instead of the presented noun *bag*), we coded it as a correct response. Since

we were interested specifically in memory for the alternative set, we split the data into recall of the alternatives (e.g., *bananas* and *cherries* in (1)) and recall of the focused element (e.g., *peaches* in (1)). First, we analyze the effect of the focus particle on the amount of correctly recalled alternatives. The data are presented in the left hand column Figure 3.3. Without a focus particle, 70.7% of the alternative items were correctly recalled, with a focus particle, recall performance improved to 76.4% and 77.4% correctly recalled items for *only* and *even*, respectively.

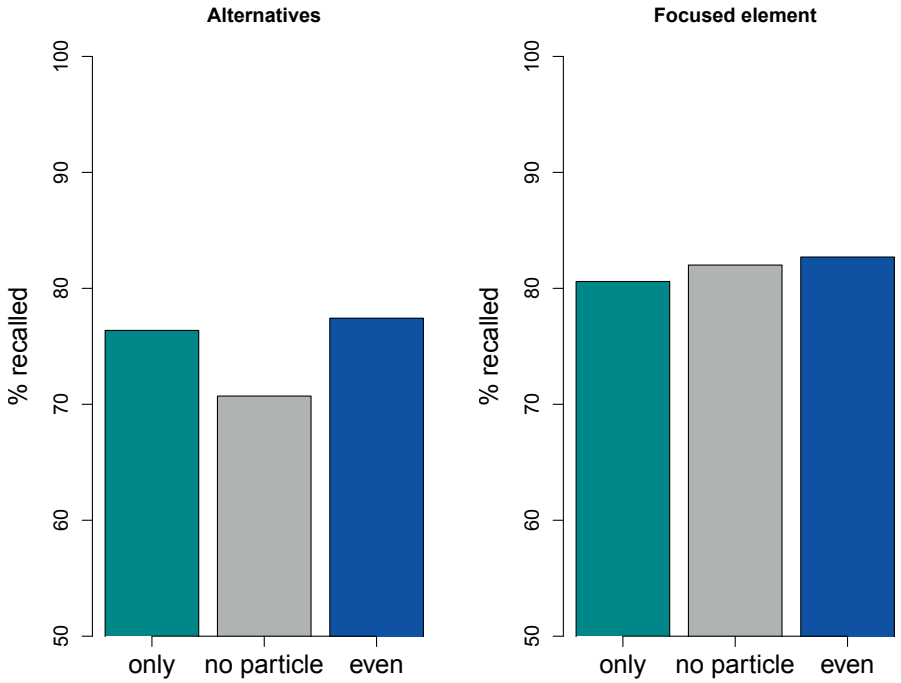

Figure 3.3: Mean percentage of recalled alternatives (left) and focused element (right) (Exp. 1a)

We fitted a series of linear mixed effects models using the package lme4 in R (Pinheiro *et al.*, 2014) and we followed the procedure described in Baayen (2008). We started out with a model that had a single random factor (subjects) and subsequently added additional random factors and random slopes. Model

comparisons by means of F tests were performed on log-likelihood values to single out the model with the best fit. Only factors that increased the model's prediction were kept in the final model.

Alternatives The model with the best fit included particle condition and trial number (centered) as fixed factors, subjects and items as random factors, and random slopes for trial number. The control condition was chosen as reference level, and p-values were extracted with Markov chain Monte Carlo (MCMC) sampling with 10000 runs. A post-hoc Tukey test on the final model (with the R-package multcomp, Bretz *et al.*, 2010) was carried out for the comparison of *only* and *even*. A summary of the model is given in Table 3.2.

Table 3.2: Results of mixed effects model for correctly recalled alternatives in Experiment 1a (n = 713, log-likelihood = -3506) including fixed effect estimates (top) and variance estimates (bottom).

	Estimate	**SE**	**t**	**pMCMC**
Intercept	70.57	4.1	17.2	
Only	6.29	2.9	2.2	0.02
Even	6.6	2.9	2.3	0.03
Trial (centered)	0.35	0.1	3.2	0.01
Random effect	$\mathbf{s^2}$			
Participant	230.37			
Item	94.53			
Random Slope	$\mathbf{s^2}$			
Trial	0.13			

The analysis revealed a significant difference between the control condition and *even* (t = 2.3, SE = 2.9, p<.05) and a significant effect for *only* (t = 2.2, SE = 2.9, p <.05). The post-hoc Tukey test showed that the recall performance for *only* and *even* did not differ significantly (p = .90).

Focused element Second, we analyzed the effect of the focus particle on the amount of correctly recalled focused elements. Figure 3.3 shows the mean percentages of focused elements on the right hand columns. The focused element was correctly recalled 81% of the time without a focus particle, 82% with *only* and 83% with *even*. Because the dependent variable was binomial (the focused element was either recalled or it was not recalled), we carried out a logit mixed model with particle condition as fixed factor and subjects and items as random factors (see Jäger, 2008). The effects of the two particles were not significant (control vs. *even*: p = .86; control vs. *only*: p = .62; *only* vs. *even*: p = .79).

3.2.4 Discussion

The first experiment investigated the impact of focus particles on long-term memory and used dialog structures in three versions: a condition with the exclusive particle *only*, the inclusive particle *even* and a control condition without a particle that also carried a pitch accent on the focused element. We found that both particles improved participants' memory for the alternatives to the focused element. From the semantics of focus particles, we had predicted that focus alternatives need to become salient to the listener during the comprehension process and have outlined two hypotheses concerning this specific process.

The results showed that it was the presence or absence of a focus sensitive particle that affected the recall performance for the alternatives, whereas the additional meaning component (inclusive vs. exclusive) of the particle had no effect. That is, memory performance for the alternatives was not differentially affected by the fact that alternatives were included or excluded, but only by the fact that focus sensitive particles grammatically depend on an alternative set, thereby enhancing memory for focus alternatives. This finding is in line with the focus association hypothesis outlined at the start of this chapter.

The focused element was recalled equally often in all conditions and its mean recall was quite high (about 82 %). However, if we were to claim that focus particles only affected recall of focus alternatives but not of the focused element itself, we would have to show an interaction between the type of recalled element and the particle condition. We tested this differential effect in a combined analysis.

We ran an omnibus generalized mixed model that contained all data coded binomially. The final model included particle condition and type of element (focused or alternative) as well as an interaction of these two factors (and it further contained trial, item and subjects as factors as well as random slopes for trial). The condition without a particle in the alternatives was chosen as reference level. The model showed a main effect of type of recalled element ($p<.0001$), showing that a focused element was recalled better than an alternative. This finding indicates that focused elements gain a privileged representation (among salient alternatives). Note that all elements were mentioned the same number of times. The fact that the focused element was best remembered overall corroborates classic findings from the literature presented in Section 2.2.1.2.

The omnibus analysis also showed significant effects of the focus particles (control vs. *only*: $p<.05$, control vs. *even*: $p<.01$). However, the interaction between focus particles and type of recalled element was not significant, suggesting that the effect was equally present for focused elements and alternatives.[4]

This lack of a significant interaction was probably due to imbalances in the two data sets (e.g., there were two alternatives but only one focused item). But in any case, no strong claims about the effect of focus particles on recall of the focused element can be made. It might be the case that a beneficial effect of the presence of a focus particle is also observed for recall of the focused element itself. Importantly, though, this does not dispute the observation that the presence of focus particles improves memory for focus alternatives.

In this experiment, we did not manipulate the presence or absence of (contrastive) focus. Rather, we investigated the effect of expressions that associate with a focused element. While the study of Fraundorf *et al.* (2010) has demonstrated that the encoding of alternatives is improved when a contrastive accent is used compared to a non-contrastive accent, we show that the presence of focus sensitive particles further improves the memory representation of the alternative set.

Why should focus sensitive particles have an effect on the mental representation of focus alternatives above and beyond intonational focus marking? If we

[4]Yet when setting the focused element as reference level, the effect of the particles disappears, suggesting that focus particles affect foremost the alternatives.

follow Rooth (1985), Rooth (1992) and Krifka (2007), the primary function of focus is to indicate the presence of interpretation relevant alternatives. Beaver & Clark (2008) distinguish between types of focus sensitivity that result from pragmatic forces and those that are lexically encoded. They argue that the focus sensitivity of focus particles is conventionalized, i.e., lexically encoded. Therefore, the presence of an alternative set would be indicated from a combination of sources - focus itself signals its presence, and this effect is reinforced by the conventionalized focus sensitivity of focus particles. We suggest that this double signaling of the relevance of an alternative set improves the encoding of the alternatives in the mental representation of the discourse, leading to better performance in the delayed recall task.

We had tried to find a context that allowed the use of minimal pairs, that is, critical sentences which differed only in the presence/absence of a focus particle and the specific particle used. In particular, the pitch accent on the focused element also had to be identical in all three contexts. Given that the two particles we used lead to different contextual assumptions, it was not easy to find a type of context that supported both of them and the absence of a particle equally well. In the materials used, the critical sentences were a correction of previously introduced expectations. In hindsight, there are two potential problems with these items, one theoretical, one based on the exact materials used. First, because a correction was used, the focus in all critical sentences was contrastive in a narrow sense (for example some theories reserve the notion of contrastive focus to corrections and parallel structures, see Krifka, 2007). This led to the fact that there was a strong exhaustiveness implicature in the condition without a focus operator. That is, if we consider the sentence *No, Carsten ate pears*, the natural interpretation is that he did not eat the other fruits mentioned before. Hence, it could be argued that the condition without a focus operator did not differ a lot conceptually from the condition with *only*. Note, however that the condition without a particle and the condition with *only* still differ theoretically, since *only* modifies the assertion of the sentence, while exhaustivity comes as an implicature in the case of the condition without particle.

Second, in the items used, the use of *even* appeared awkward to some, but not all listeners. A rating study, presented in Section 3.4 confirms this intuition

and this issue will be further discussed in that section. In Experiment 1b, we wanted to test whether the effects generalize to contexts where the exhaustiveness implicature is less prominent, where *only* and *even* were equally appropriate contextually, and with stimuli that have a narrative structure without a correction.

3.3 Experiment 1b: Replication with narrative item structure

3.3.1 Goals and predictions

Experiment 1b served to replicate the findings of Experiment 1a and to see whether the effects of focus particles generalize over different linguistic structures. For example, it might be that the correction also made the alternatives more salient. Since we are interested in the effect of the semantics of focus particles, we used a narrative item structure in Experiment 1b that did not involve the correction. If the effects we observed in Experiment 1a are due to the presence of focus particles, we should observe comparable effects in a different linguistic environment.

3.3.2 Methods

3.3.2.1 Participants

A total of 33 native speakers of German (21 female and 12 male, mean age 25.7 years, SD 2.65, age range 21-32) were recruited from the same subject pool and paid seven Euros in compensation. None of them reported any vision or hearing difficulties.

3.3.2.2 Materials

We created a set of 45 experimental items (30 items were based on the material in Experiment 1a and 15 additional experimental items) and 35 filler items (20 items based on Experiment 1a and 15 additional filler items). The narrative

structure used in Experiment 1b followed the schema in (2). The first context sentence mentioned a set of three elements and connected the person with the setting. The second continuation sentence continued the story and served to ease accommodation. Finally, the critical sentence referred back to the list and focused one of the elements. We again used the three particle conditions as in Experiment 1a: the exclusive particle *only*, the inclusive particle *even* and the control condition without a focus particle. All sentences were recorded by myself.

(2) **Context sentence:**
Matthias erhält ein Paket mit Hemden, Hosen und Jacken
'Matthias receives a package with shirts, trousers and jackets.'
Continuation sentence:
Er guckte, was ihm gefiel
'He considered what he liked'
Critical sentence:
(a) Er hat nur die [Hemden]$_{F}$ behalten
(b) Er hat sogar die [Hemden]$_{F}$ behalten
(c) Er hat die [Hemden]$_{F}$ behalten
'He kept (a) only/ (b) even/ (c) _ the [shirts]$_{F}$'

Care was taken that, across items, the focused element in the critical sentence was equally often the first, second, or third element from the first context sentence. Again, the critical sentences with particles were pronounced with a hat contour (Féry, 1993) and the condition without particle had a falling pitch accent on the focused constituent.

We again conducted acoustic analyses of the focused element across the three particle conditions. Figure 3.4 displays the mean pitch contour of the focused word (e.g., *Hemden* in (2)) across conditions. As the figure shows, the pitch contours closely resembled each other across conditions. In comparison to Experiment 1a, the pitch accent was less prominent, which is likely due to the (lack of) correction. Table 3.3 summarizes the results of the statistical analyses. The only significant difference across conditions was the lower minimum pitch of the entire word in the condition with *even*.

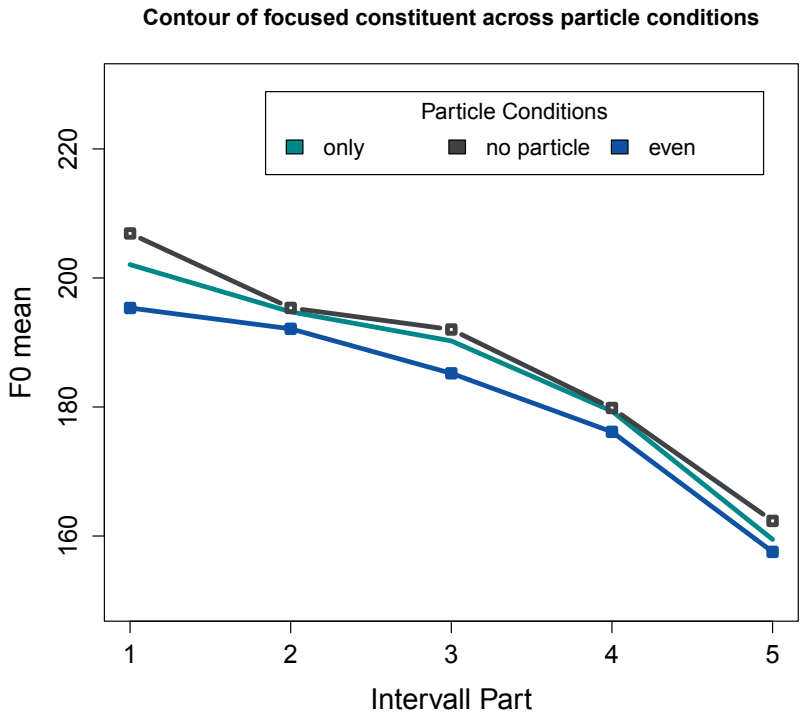

Figure 3.4: Mean pitch contour of the focused element in Experiment 1b

Table 3.3: Mean acoustic parameters of the focused element in the critical sentences (e.g., *Hemden* in (2)).

Measure	***Only***		**No particle**		***Even***		**F**	**p**
	Mean	SE	Mean	SE	Mean	SE		
Stressed syllable								
Duration (s)	0.24	0.01	0.23	0.01	0.23	0.01	1	0.37
Max pitch (Hz)	224	12.5	231	15.3	230	15.8	<1	0.78
Min pitch (Hz)	180	3.48	175	3.74	171	3.11	1.83	0.17
Pitch diff.	45	12.7	56	15.1	59	15.9	1.17	0.31
Mean pitch (Hz)	195	3.87	196	5.05	194	5.07	<1	0.69
Point of max (s)	0.1	0.01	0.11	0.01	0.1	0.01	<1	0.98
Point of min (s)	0.17	0.02	0.16	0.02	0.15	0.02	<1	0.5
Entire word								
Duration (s)	0.43	0.01	0.43	0.01	0.42	0.01	1.85	0.16
Max pitch (Hz)	233	14.3	240	16.5	239	17.1	<1	0.77
Min pitch (Hz)	148	3.24	148	3.28	143	3.87	12.17	0
Pitch diff.	85	14.4	92	16.9	95	17.1	1	0.37
Mean pitch (Hz)	183	2.31	184	3.21	181	3.01	<1	0.84
Point of max (s)	0.13	0.02	0.12	0.02	0.12	0.02	1	0.36
Point of min (s)	0.4	0.02	0.38	0.02	0.38	0.02	1	0.36

The items were constructed according to the same criteria as in Experiment 1a (a list of all items can be found in Appendix A.2). Half of the experimental items contained the definite determiner (German *die* or *der*) before the noun and half of them did not, depending on what sounded natural in the given contexts. This time, the filler items were only recorded in the version without particle and consequently there were no filler questions about the particles. We had omitted filler questions about particles in order to avoid drawing attention to their existence in the stimuli. Each participant received the same filler items with the same questions. Filler questions could concern the setting, the name of the protagonist, or the action. The experimental questions mentioned the category and the setting (e.g., *Which pieces of clothes were in the package?* for example (2)), requiring participants to recall the focused element and the alternatives.

Each participant was exposed to all 45 experimental items and 35 filler items in eight blocks of ten stimuli. The conditions were rotated across the experimental stimuli according to a Latin Square Design. This resulted in a total of three lists that were pseudo-randomized for each participant. The following constraints were set for randomization: no more than three filler or experimental trials were presented in a row, the particular particle condition appeared at most three times in a row and, within a block, a category (e.g., fruit) appeared only once.

3.3.2.3 Procedure

The procedure was the same as in Experiment 1a, with one exception: Instead of five blocks, eight blocks were presented in Experiment 1b, and the experiment lasted 50 minutes.

3.3.3 Results

The recorded answers were transcribed and coded in the same way as in Experiment 1a. Again, we first looked at the correctly recalled focus alternatives. Figure 3.5 depicts participants' performance for the alternatives (left) and focused elements (right). 59.7% of the items were recalled in the control condition, 64.3% with *only*, and 64.2% with *even*.

Alternatives The same mixed effects model as in Experiment 1a was fitted to the data. A summary of the model is given in Table 3.4.

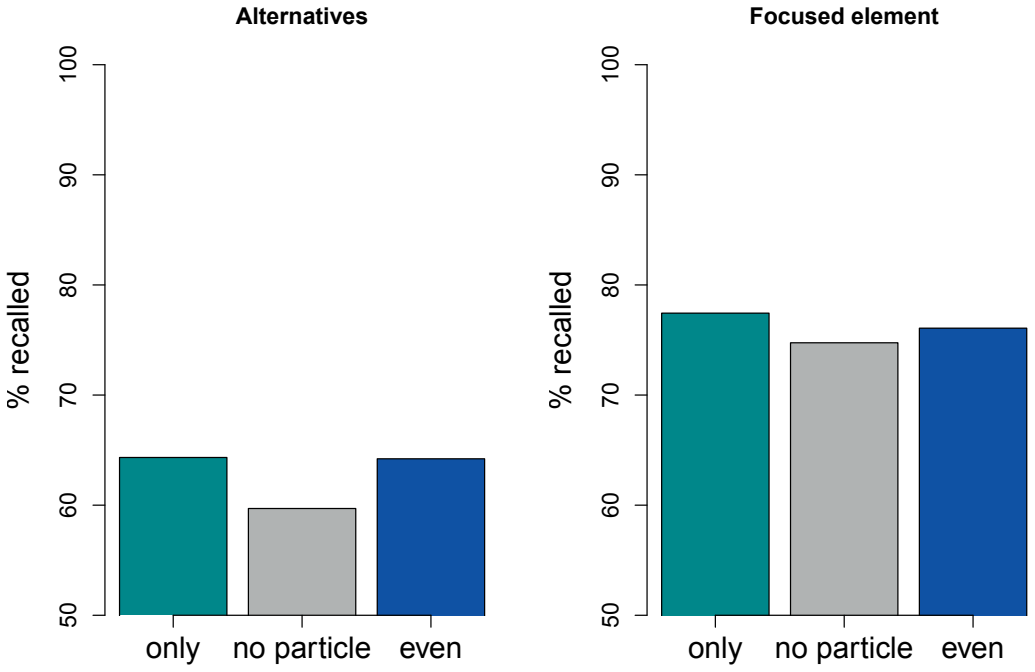

Figure 3.5: Mean percentage of recalled alternatives (left) and focused element (right) (Exp. 1b)

The model yielded a significant effect for *even* ($t = 2.1$, $SE = 2.2$, $p<.05$) and *only* ($t = 2.1$, $SE = 2.2$, $p<.05$). A post-hoc test revealed no difference between *even* and *only* ($p = 1.0$).

Focused element The focused element was correctly recalled 75% of the time without a focus particle, 77% with *only* and 76% with *even*. The recall of the focused element was not affected by the particle condition (control vs. *even*: $p = .59$, control vs. *only*: $p = .28$, *only* vs. *even*: $p = .85$).

Table 3.4: Results of mixed effects model for correctly recalled alternatives in Experiment 1b (n = 1476. log-likelihood = -7373) including fixed effect estimates (top) and variance estimates (bottom).

	Estimate	**SE**	**t**	**pMCMC**
Intercept	59.7	3.9	15.4	
Only	4.63	2.2	2.1	0.04
Even	4.51	2.2	2.1	0.05
Trial (centered)	0.14	0.06	2.4	0.03
Random effect	$\mathbf{s^2}$			
Participant	314.02			
Item	141			
Random Slope	$\mathbf{s^2}$			
Trial	0.06			

3.3.4 Discussion

Experiment 1b replicates the main results from Experiment 1a: The presence of a focus particle improved memory for focus alternatives (but not the memory for the focused element itself). Recall was affected by the presence of a focus particle, but not by the particular focus particle used, supporting the focus association hypothesis and refuting the lexical meaning hypothesis. We did not observe a difference for inclusive and exclusive particles. That does not mean that these particles do not affect how a listener interprets a sentence. For example in studies on sentence processing it was found that *only* and *even* elicit different expectations concerning the upcoming material (Filik *et al.*, 2009 and Kim, 2012). However, both types of particles require a salient set of alternatives and this seems to be what makes listeners better remember the alternatives on the long run.

The items used in Experiment 1b did not involve a corrective statement in the critical sentence, but the particles were embedded in a declarative statement. The pattern of results looked exactly the same as in Experiment 1a, suggesting that the observed effects can be traced back to the semantics of the focus particles.

Again, we carried out an omnibus analysis which showed a main effect of focus ($p < .0001$, focused elements were again recalled better than alternatives), better recall in the conditions with *only* and *even* compared to the control condition ($p < .05$ respectively) but no interaction between type of element and particle condition. Recall performance was lower on average in this experiment compared to the first, especially for the alternatives. We believe that this is due to two factors. First, Experiment 1b was longer than Experiment 1a (eight blocks with ten items each instead of five blocks with ten items each), which might have decreased performance due to fatigue but also more interference from previously recalled information in Experiment 1b. Second, while both the focused element and the alternatives were named twice in Experiment 1a, the alternatives were only named once in Experiment 1b (whereas the focused element was still named twice). The first factor affects recall of alternatives and the focused element equally, while the second factor only affects recall of the alternatives which might explain why performance for alternatives dropped more than performance for the focused element.

Overall, the results of Experiment 1a and 1b extend the findings of Fraundorf *et al.* (2010) to the domain of focus particles. To conclude, focus particles lead to deeper encoding of the alternative set due to the fact that such particles require a salient set of alternatives.

3.4 Rating Study 1: Acceptability of experimental items

In the two experiments just presented, we attempted to create a context that was equally suitable to use the particle *even* and *only*. As described in Chapter 2, the particle *even* carries a presupposition of likelihood and an additive presupposition which need to be satisfied in the context. The particle *only* does not trigger the same kinds of presuppositions, therefore it was difficult to find a context that was equally appropriate for the two particles.

In the post-experimental questionnaire, participants seemed to have understood the targeted meaning of the sentences. However, to some participants the

sentence with *even* sounded somewhat awkward, especially in the first experiment where *even* was embedded in the correction. We therefore carried out a rating study with the items of the two experiments to quantify their contextual appropriateness. In this study, we presented the target sentences to a group of participants and asked them to rate the contextual appropriateness of the critical sentence, given the two context sentences (a scale from 1 to 7 was used, with 1 representing *completely inappropriate* and 7 *very appropriate*).

3.4.1 Methods

3.4.1.1 Participants

24 participants (six male, 18 female) from the same population as in the experiments reported in the body of the paper participated in the rating study. Their mean age was 24.5, with a range from 20-30. They were paid five Euros in compensation. None of them had taken part in the recall experiments.

3.4.1.2 Materials

The experimental items from Experiment 1a (30) and Experiment 1b (45) were used. Three lists were created such that an item appeared only in one condition (with *only*, with *even*, control without a particle) within a given list but so that the three conditions appeared equally often on each list. Thirty-eight filler items were created that contained violations of semantic or pragmatic appropriateness. (3)-(a) shows an example where the continuation is contextually incongruous. In example (3)-(b), the use of *only* in combination with the affirmative *yes* is infelicitous. Each list contained the same filler items, such that a given list contained 113 items.

(3) a. The adult education center offers classes in drawing, photography, and sewing
I bet, Marius has attended classes for photography and sewing
Yes, he has painted pictures

b. On the playground, there are monkey bars, swings, and slides
I bet, Sophie has used slides and swings
Yes, she has only used monkey bars

3.4.1.3 Procedure

Participants listened to the sentences via headphones and were instructed to indicate the contextual appropriateness of the third sentence, given the preceding two sentences. Participants were required to make their judgment on a scale from 1-7, with 1 representing *completely inappropriate* and 7 *very appropriate*. Answers were given on a key board by pressing a number from 1 to 7. Each participant was presented with one experimental list only. The entire test session lasted about 25 minutes.

3.4.2 Results

Table 3.5 shows the mean ratings across conditions for the two experiments. As can be seen from the table, the sentences with *even* were less acceptable than the other conditions, however still far more appropriate than the filler sentences.

We carried out a linear mixed effects analysis with all data. The final model contained the fixed factors Experiment (1a vs. 1b) and particle condition (*only*, *even*, no particle) and the random factors participants and items. This time, *only* (Experiment 1) was chosen as the reference level since we were interested in the differences between the two conditions with particles.

The model showed a significant effect of Experiment ($p<.0001$), a significant difference between *only* and *even* ($p<.0001$), and a significant interaction between Experiment and particle condition (*only* vs. no particle: $p<.001$; *only* vs. *even*: $p<.0001$), illustrating that the difference between *only* and *even* was smaller in Experiment 1b than in Experiment 1a. Table 3.6 shows the results of the mixed model.

Table 3.5: Mean appropriateness ratings for items used in Experiments 1a and 1b

Exp./Condition	***Only***	**No particle**	***Even***	**Filler**
Experiment 1a	6.5	6.4	5.1	1.7
Experiment 1b	5.6	6.0	5.1	2.4

Table 3.6: Results of mixed effects model for appropriateness ratings in Rating Study 1 (n = 2250, log-likelihood = -3976) including estimates, confidence intervals and p-values.

	Estimate	**Lower**	**Upper**	**pMCMC**
Intercept	6.51	6.28	6.73	0.0001
No particle (Exp. 1)	-0.07	-0.29	0.16	0.51
Even	-1.45	-1.67	-1.24	0.0001
Exp. 2	-0.87	-1.07	-0.65	0.0001
No particle:Exp. 2	0.47	0.19	0.75	0.001
Even:Exp. 2	0.91	0.62	1.18	0.0001

3.4.3 Correlational analyses: Acceptability and recall

In order to make sure that the reduced acceptability of the sentences did not affect recall performance, correlational analyses were run. In particular, it might be the case that the reduced acceptability of the condition with *even* led to worse recall, possibly masking any differences between the condition with *even* and *only*. We carried out separate correlations for the materials of Experiment 1a and Experiment 1b and separate correlations for the two focus particles, paying particular attention to the condition with *even*, because this is where an appropriateness effect should emerge. In Experiment 1a, the correlation between the ratings and the recall performance was r = -.09, p = .66 for items with *even* and r = -.43, p<.05 for items with *only*. In Experiment 1b, the correlation was r = -.0004, p = .99 for items with *even* and r = .08, p = .62 for items with *only*. Hence, the only significant correlation showed that recall was worse for items which were contextually more appropriate, and this was only the case for one set of items in the presence of *only*.[5] These observations speak against a trade-off of the effect of focus particles and contextual appropriateness which might have masked an additional effect of lexical meaning.

The correlational analyses indicate that the slightly reduced appropriateness did not seem to have affected participant's recall performance. Another aspect that speaks against such a trade-off is that we employed the same manipulation in two different linguistic contexts and found the same pattern of results.

Finally, the comparison to the filler items with mild pragmatic or semantic violations indicates that the sentences with *even* were not completely odd (5.1 out 7 for *even* and 2.05 on average for filler items).

3.5 Chapter summary

The first two experiments of this thesis lend support to the focus association hypothesis formulated in the beginning of this chapter. We found that the exclusive particle *only* and the inclusive particle *even* facilitated recall of contextually-

[5]Note also that in this experiment (1a) ratings were similar for *only* and the control condition.

introduced alternatives to a similar extent. The results hence provide evidence that the presence (vs. absence) of a particle leads to better encoding of the alternative set and consequently better retrieval of focus alternatives. In addition to the effect of focus particles, we found an overall effect of focus such that the element in focus was better remembered than the alternatives. This suggests that focal elements have a privileged representation in the listener's mind.

Chapter 4

The mechanisms of activation and competitive inhibition

The fourth chapter looks at more immediate representations of focus alternatives. In particular, it explores the mechanisms by which the representation of the alternative set emerges and the impact of focus particles on these mechanisms. Experiments 2 and 3 investigate the retrieval/activation of mentioned alternatives and additional unmentioned alternatives. The overall goal of the experiments is to assess the activation and competition among members of the alternative set.[1]

4.1 Goals of Experiments 2 and 3

Our delayed recall experiments have revealed that focus particles make contextually-introduced alternatives salient in a listener's long-term memory. The previous online studies presented in Chapter 2 indicated that the representation of alternatives unfolds and changes with time (in particular Husband & Ferreira, 2016). What is more, previous studies have provided mixed results concerning the question whether focus alternatives are activated/facilitated or inhibited. To find out how the representation of alternatives emerges in the listener's mind, it is hence crucial to examine the impact of focus particles on more immediate representations of focus alternatives.

[1]This chapter is a version of the article Gotzner *et al.* (2016). Experiment 2 and 3 were designed by Katharina Spalek and myself. I analyzed all data and wrote the article.

The specific goal of the experiments presented here is to investigate the process and the mechanisms underlying the construction of and access to alternative sets instantiated by focus particles. By using two different experimental paradigms, a probe recognition paradigm and a lexical decision paradigm, we investigate how different task demands might affect how participants engage in processing sentences with focus particles. Further, we compare the retrieval of contextually-mentioned alternatives to that of unmentioned possible alternatives.

With the probe recognition task (Experiment 2), we examine the competition of (mentioned and unmentioned) alternatives in a situation where participants have to indicate whether a possible alternative had been mentioned or not. In this task, a comparison can be made across the whole set of alternatives, including the focused element. With the lexical decision task (Experiment 3), we tap into the lexical level, measuring whether a particular word was already activated in the listener's mental lexicon. In particular, we are interested in whether mentioned and in addition unmentioned alternatives become activated. The comparison of both experiments will allow us to draw conclusions about the mechanisms involved in establishing alternative sets. In particular, we propose that (i) initially a large cohort of semantic competitors is accessed from the mental lexicon, including mentioned and unmentioned alternatives and that (ii) focus particles lead to a stronger competition among members of the alternative set.

4.2 The probe recognition task

In Experiment 2, we use a probe recognition paradigm to investigate how focus particles influence the representation of alternatives and by which mechanisms alternative sets are established. The probe recognition task is frequently used to examine the representation of discourse concepts (e.g., McKoon & Ratcliff, 1980, MacDonald & Just, 1989, Glenberg *et al.*, 1987 and Gernsbacher & Jescheniak, 1995). Several earlier studies indicate that participants' performance in the probe recognition task not only reflects superficial knowledge of a text (e.g., the features of the text itself) but rather the underlying structure of the events described (Glenberg *et al.*, 1987, Gernsbacher & Jescheniak, 1995).

Of particular relevance for the current experiment is a previous probe recognition study by Gernsbacher & Jescheniak (1995). They investigated the impact of pitch accents on discourse concepts. Participants heard short narratives of the form *[...] I mean like last Saturday we went to one near campus, 'n she just had to buy an ashtray, 'n y' know* [...] and were asked to recognize the visually-presented probe ASHTRAY after the last phrase given in the example. When the word *ashtray* was stressed, its activation was higher than when it was pronounced neutrally, reflected in faster probe recognition times. A further experiment found that introducing a novel unrelated concept[2] with a pitch accent ([...], *then she saw a VASE*) inhibited the previously-mentioned concept *ashtray* relative to condition where *vase* was pronounced neutrally. In an experiment where the word *vase* as well as *ashtray* carried an accent (*'n she just had to buy an ASHTRAY,* [...], *then she saw a VASE*), no inhibition of the previously mentioned concept *ashtray* was present. To account for this pattern of results, Gernsbacher & Jescheniak (1995) propose that pitch accents activate the accented concept, inhibits previously-mentioned concepts and prevents inhibition from novel concepts. We believe that the probe recognition task is well-suited to investigate the evolving representation of focus alternatives, because it measures how a concept is represented in a listener's discourse model of a text and thereby reflects what elements listeners consider in the set of alternatives.

[2]The authors argue that inhibition should only be present for unrelated concepts, but all studies presented in the introduction indicate that especially semantically-related words are affected by contrastive prosody. A question would be what particular accent type was used in the study of Gernsbacher & Jescheniak (1995) but this information is not provided. It should further be crucial whether the test words can replace the focused element or not (a question addressed in the next chapter).

4.3 Experiment 2: Mentioned and unmentioned alternatives

4.3.1 Rationale and predictions

Participants in Experiment 2 were exposed to the same auditory dialogs used in Experiment 1a that either contained the particle *only*, *even*, or no particle. The stimuli introduced a set of three elements, repeated two alternatives and mentioned the focused element in the final critical sentence (*In the fruit bowl, there are peaches, cherries and bananas. I bet, Carsten ate cherries and bananas. No, he only/even/_ ate peaches.*). A dialog was followed by a probe word presented visually on the computer screen. The participants' task was to indicate whether the probe had appeared in the discourse or not and we measured the time it took subjects (1) to recognize a probe that was part of the introduced alternative set (mentioned alternative: CHERRIES), (2) to correctly reject a probe of the same semantic category that had not been mentioned in the discourse (unmentioned alternative: MELONS) and (3) to reject a noun that had no semantic or associative relation to the focused element and alternative set (unrelated: CLUBS).

Concerning the representation of focus alternatives, the account by Gernsbacher & Jescheniak (1995) makes two predictions. First, it predicts that focal stress activates the focused word itself (which is not addressed in our study but has been attested by Norris *et al.*, 2006, Sturt *et al.*, 2004, Fraundorf *et al.*, 2010 and others). Second, it predicts that the pitch accent on the focused element inhibits the previously-mentioned alternatives. We might further derive the hypothesis that focus particles cause a stronger inhibition of the alternatives (compared to bare intonational focus) due to the stronger association with focus. The specific predictions for the three different probe types are summarized below:

(1) Concerning the recognition of the mentioned alternatives, there are two alternative hypotheses. First, it is possible that the mentioned alternatives are more accessible in the two conditions with focus particles compared to the condition without a particle; considering the results of the priming studies that manipulated focus accenting (Norris *et al.*, 2006; Braun & Tagliapietra, 2010; Husband

& Ferreira, 2016). However, these studies employed a manipulation of focus intonation and no set of alternatives was introduced contextually. The account by Gernsbacher & Jescheniak (1995) predicts that pitch accents inhibit previously-mentioned concepts when several concepts are introduced in a discourse. Therefore, the second hypothesis is that we observe an inhibitory/interference effect, because the accented focused element (and possibly focus particles) might inhibit the previously-mentioned alternatives (see also Byram-Washburn, 2013). Another reason for an interference effect of focus particles might be that these particles establish an association between the focused element and its alternatives, thereby increasing the competition between these elements.

(2) In rejecting the unmentioned alternatives, we should observe a processing difficulty since focus particles should lead participants to infer the presence of alternatives. If participants consider those possible alternatives, it should be more difficult for them to reject unmentioned alternatives in the condition with focus particles relative to the condition without a focus particle.

(3) The unrelated probes serve as a control. Accordingly, we do not expect focus particles to exert an influence on the rejection of unrelated items.

4.3.2 Methods

4.3.2.1 Participants

Fourty-four native speakers of German (33 female, 11 male, mean age 25.6 years, age range 21-31) were recruited from a participant pool at the Institute of Psychology of Humboldt University and paid seven Euros in compensation. None of them reported any vision or hearing difficulties. The data of two subjects were excluded from the analysis due to technical problems. The remaining participants were 31 women and 11 men with a mean age of 26.2 years. Four participants were left-handed and the remaining participants were all right-handed.

4.3.2.2 Materials

In Experiment 2, the same items were used as in Experiment 1a. Each of the 30 critical items was paired with a set of three probe words: a mentioned alternative, an unmentioned alternative and an unrelated probe of comparable frequency and

word length (a full list of probes can be found in Appendix A.5, corresponding to the items in Appendix A.1). One of the mentioned alternatives (see the continuation sentence in (1)) was selected, counterbalancing across items whether it was the first or second one.

(1) **Context sentence (speaker 1):**
In der Obstschüssel liegen Pfirsiche, Kirschen und Bananen
'In the fruit bowl, there are peaches, cherries, and bananas'
Continuation sentence (speaker 1):
Ich wette, Carsten hat Kirschen und Bananen gegessen
'I bet Carsten ate cherries and bananas'
Critical sentences (speaker 2):
(a) Nein, er hat nur [Pfirsiche]$_{F}$ gegessen
(b) Nein, er sogar [Pfirsiche]$_{F}$ gegessen
(c) Nein, er hat [Pfirsiche]$_{F}$ gegessen
'No, he (a) only/(b) even/(c)_ ate [peaches]$_{F}$'

The word length and frequency of all probe nouns were extracted from the dlexDB database (see Heister *et al.*, 2011) and statistical analyses (univariate between item ANOVAs with probe type as factor) were performed to compare the three probe types on word length and frequency. Table 4.1 summarizes the mean values, standard errors and results from the ANOVAs for the two measures. Word length and frequency of the probes was not significantly different across probe conditions.

Table 4.1: Word length and frequency of the mentioned alternatives, unmentioned alternatives and unrelated probes.

Measure	**Mentioned**		**Unmentioned**		**Unrelated**		$\mathbf{F_{(2,87)}}$	**p**
	Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*		
Letters	6.3	0.23	6.83	0.32	6.93	0.27	1.53	0.22
Frequency	4.93	1.1	5.25	1.11	6.81	3.5	0.2	0.82

The expected answer was *yes* on a third (mentioned alternatives) and *no* on

two thirds of the critical trials (unmentioned alternatives and unrelated probes). A set of 20 filler items was constructed to counterbalance the expected answers from the critical items and to ensure that participants paid attention to the entire discourse. Either verbs (25) or nouns (20) from the setting sentence or the names of the protagonist (15) served as probe for the filler items. The fillers had the same structure as the experimental items so that participants could not develop a strategy to expect a certain type of probe depending on the structure of an item. Two thirds of the filler trials required the participants to respond *yes* and a third of the trials required them to respond *no*, thereby equating the overall number of expected *yes* and *no* responses.

The 50 items (30 experimental and 20 filler items) were repeated three times, appearing in each of the particle conditions combined with a different probe word. This resulted in a total of 150 trials per participant with ten critical items per combination of particle (*only*, *even*, no particle) and probe condition (alternatives, unmentioned alternative, unrelated). The stimuli were spread across three experimental blocks separated by a short break. Six experimental lists were created by rotating through the particle conditions and probe types according to a Latin square design. A given list was pseudo-randomized for each subject with the program Mix (van Casteren & Davis, 2006). The following constraints were set for randomization: no more than three filler or experimental trials were presented in a row, a given particle condition appeared at most twice in a row. Within one block, an item appeared only once. Additionally, the expected responses (*yes* or *no*) were controlled so that a participant was required to give the same response in no more than four subsequent trials.

4.3.2.3 Procedure

The experiment started with an instruction displayed on the computer screen. The instruction told the participants that they will be presented with auditory stimuli and that their task is to decide whether a word had appeared in the preceding story or not. They were also instructed to respond as accurately and as quickly as possible and to listen to the exact wording. After the instructions

were displayed, subjects performed four practice trials and were allowed to adjust the sound volume.

The basic structure of a trial is exemplified in Figure 4.1. Each trial began with the onset of a central fixation cross displayed for 700 ms followed by a dialog that was presented over headphones. Each of the sound files included 2000 ms of silence after the last critical sentence. With an offset of 50 ms a probe appeared on the screen and the participants had to indicate by button press whether or not it had appeared in the preceding dialog. The probe word stayed on the screen until a response was made. If subjects did not respond within 4000 ms, the trial counted as a miss. With an offset of 500 ms the next trial was initiated. After a total of 50 trials, subjects had a short break. In total, there were three experimental blocks.

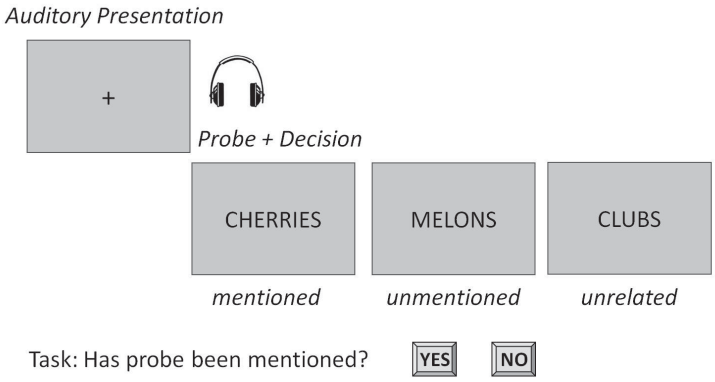

Figure 4.1: Trial sequence: Probe recognition

At the end of the experiment, subjects were asked to fill in a form asking for basic demographic information. All subjects were tested individually and an entire session lasted about 45 minutes.

4.3.3 Results

Trials in which subjects responded incorrectly were excluded from the analysis (1.8 %). We further excluded RTs more than two standard deviations from a participant's mean in a given combination of particle and probe condition (5.5 %).

Figure 4.2 displays the mean RTs of unrelated items, mentioned alternatives and unmentioned alternatives across particle conditions based on the overall model reported below.

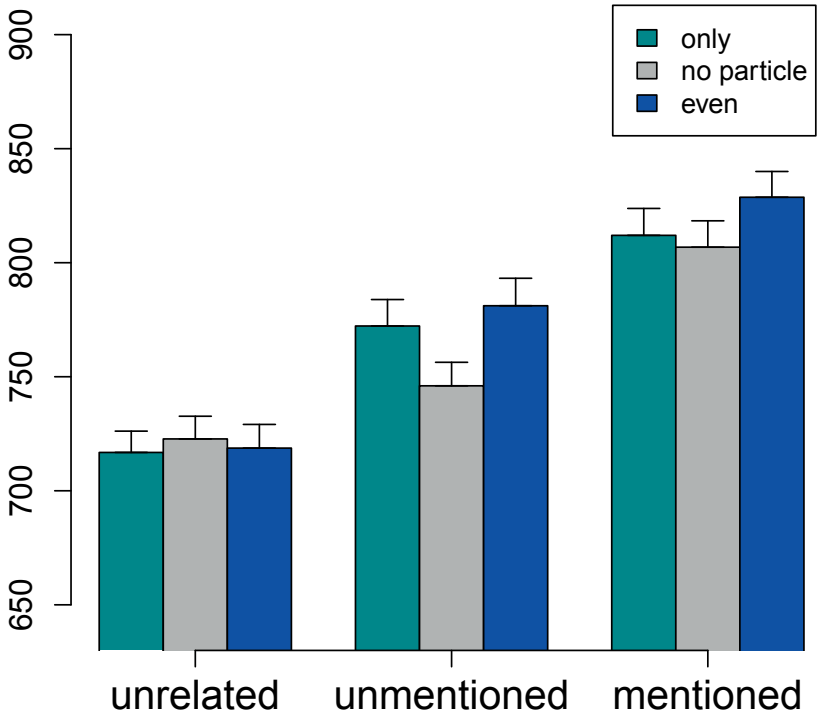

Figure 4.2: Mean RTs of unrelated items, unmentioned alternatives and mentioned alternatives (Exp. 2). Error bars represent standard error

The log-RTs for correct responses were fitted with a series of mixed effects models using the package lme4 in R (Pinheiro *et al.*, 2014). We followed the procedure described in Baayen (2008). We started out with the minimal model, adding further random variables and random slopes. Model comparisons by means of F tests were performed on log-likelihood values to single out the model with the

best fit. Only factors that increased the model's prediction were kept in the final model. Further outliers that were not explained by the model were removed at the stage of model criticism based on the distribution of fitted values and residuals (Baayen, 2008, p. 279ff).

The final model contained the log-RTs, fixed factors for particle condition, probe type and their interaction and fixed effects of trial (mean centered) as well as random factors for items, subjects and random slopes for trial. We used the Helmert coding system for the factor particle: the first contrast named particle presence evaluates the presence vs. absence of a particle (the mean of *only* and *even* vs. no particle) and the second contrast named particle type evaluates the difference between *even* and *only*. The no particle condition of the unmentioned alternatives was chosen as the baseline (treatment coding) in order to evaluate the difference between unmentioned alternatives and unrelated items as well the mentioned alternatives regarding the effect of the particle conditions. Eighty-two additional outliers were removed (2.3 %).

Effect of probe type Concerning the overall comparison of the different probe types, the model revealed two significant main effects: unrelated items were rejected faster than the unmentioned alternatives ($t = -10.16$, $SE = .006$, $p < .0001$) and the recognition of the mentioned alternatives was slower than the rejection of the unmentioned alternatives ($t = 7.81$, $SE = .006$, $p < .0001$).

Effect of focus particles We were specifically interested in the effects of the focus particles *even* and *only*. The model showed a significant main effect of the presence vs. absence of a particle (presence: $t = 3.21$, $SE = .01$, $p < .001$). This main effect demonstrates that the particles *even* and *only* caused interference effects relative to the condition without a particle. There was no significant difference between the two particles types (particle type: $p > .38$). Overall reactions in the conditions with *even* and *only* were hence similar.

4.3.3.1 Interaction of probe type and focus particles

Furthermore, there was a significant interaction between probe type and the presence of a particle in the unrelated items (presence: unrelated: $t = -2.14$, SE

= .014, p <.05). This significant interaction reflects that the effect of a focus particle was present for unmentioned (and mentioned) alternatives but not for unrelated items. There was no interaction between the specific type of particle used and the unrelated items (particle type: unrelated: p >.3). Hence, the two particles *even* and *only* again did not differ in the unrelated items.

There was no significant interaction between mentioned and unmentioned alternatives suggesting that similar interference effects of the particles were present for either type of alternatives (presence: mentioned: p >.6). That is, the particles *only* and *even* interfered with the correct recognition of mentioned alternatives and with the rejection of unmentioned alternatives. However, there was a marginal interaction between the specific type of particle used and the mentioned alternatives (particle type: mentioned: p = .073). This marginal interaction reflects the fact the effect of *only* in the mentioned alternatives was slightly though not significantly smaller than that of *even*. The results of the overall model are detailed in Table 4.2.

Table 4.2: Results of mixed model for Experiment 2 (n = 3429, log-likelihood = 1160) including estimates, confidence intervals and p-values.

	Estimate	**Lower**	**Upper**	**pMCMC**
Intercept	6.6189	6.5810	6.6598	0.0001
Particle presence	0.0336	0.0131	0.0543	0.0006
Particle type	0.0105	-0.0128	0.0342	0.3842
Unrelated	-0.0699	-0.0834	-0.0559	0.0001
Mentioned	0.0540	0.0402	0.0674	0.0001
Trial	-0.0015	-0.0019	-0.0012	0.0001
Particle presence: unrelated	-0.0314	-0.0610	-0.0028	0.0316
Particle type: unrelated	-0.0174	-0.0514	0.0155	0.3026
Presence: mentioned	0.0078	-0.0249	0.0418	0.6604
Particle type: mentioned	-0.0265	-0.0560	0.0025	0.0736

4.3.4 Discussion

Participants were presented with auditory dialogs that mentioned a set of three elements and they had to perform a recognition memory task on a visually-presented probe after exposure to the dialogs. We observed significant interference effects of the two particles in the rejection of the unmentioned alternatives: rejections were slower when a particle was present compared to absent; regardless of which particle (*even* and *only*) was used. The lack of a significant interaction between unmentioned and mentioned alternatives regarding the overall particle effect indicates that similar interference effects were present in the recognition of mentioned alternatives. However, there was a marginal interaction between the specific type of particle used and the mentioned alternatives, suggesting that the effects of *only* tended to be smaller than that of *even*.

There was a significant interaction of the overall particle effect (presence vs. absence) and the probe types. This indicates that the interfering effect of focus particles was present for mentioned and unmentioned alternatives but not for unrelated items. Overall, the recognition of the alternatives was slowest, the rejection of the unmentioned alternatives intermediate and the rejection of the unrelated items fastest. In the following, I will discuss the effects separately for the three different probe types.

Unmentioned alternatives We found interference effects of focus particles in the rejection of the unmentioned alternatives. These effects provide evidence that listeners consider a set of unmentioned alternatives. We assume that focus particles act like a placeholder[3] triggering a search for alternatives from the mental lexicon. According to Rooth (1992), focus evokes a set of various possible replacements of the focused element and a subset of this initial set is selected by the context. Therefore it seems plausible that a large cohort of semantic competitors is activated/considered even if the context is restricted to a specific set of elements. It is unlikely that listeners are committed to the unmentioned alternatives in the sense that they store all possible alternatives. Rather, the interference effects of focus particles arise because the unmentioned alternatives can replace

[3]I thank Stephen Crain for suggesting this metaphor.

the focused element and hence match the placeholder. Note, however that the task required participants to reject the unmentioned alternatives, therefore the interference effect could be due to a stronger competition or a stronger activation of unmentioned alternatives caused by focus particles. In Experiment 3, we use a lexical decision task to test these two alternative hypotheses.

Mentioned alternatives In the correct recognition of the mentioned alternatives we also found interference effects. That is, the presence of a focus particle decreased a listeners ability to correctly accept a mentioned alternative. We propose that the interference effect in the mentioned alternatives is due to the competition among the mentioned alternatives and the focused element (and possibly unmentioned alternatives) while constructing the set of alternatives. As we have outlined, there might be two reasons for such a competition. First, Gernsbacher & Jescheniak (1995) found that pitch accents inhibit previously-mentioned concepts and our stimuli contained a pitch accent in all conditions. Second, focus particles might cause a stronger competition between the focused element and its alternatives due to the fact that focus particles associate with focus. That is, focus particles factor the alternatives into truth-conditional meaning (while bare intonational focus does not have a truth-conditional impact). For example, a sentence like *Anna only ate bananas* expresses that (i) Anna ate bananas and (ii) that she did not eat pears or melons. In this sense the relation between the focused element and its alternatives is highlighted by a focus particle.

In addition to the effect of focus particles, there is also some evidence for an overall inhibition of the alternatives by pitch accents as stipulated by Gernsbacher & Jescheniak (1995). The recognition of the mentioned alternatives was overall slower than the rejection of the unmentioned alternatives (and unrelated items) even though those alternatives were mentioned twice and should therefore have been highly active (see also Experiment 2). This points to the fact that, in the probe recognition task, listeners search through the whole set, possibly considering the focused element as well. So, there might be a mechanism that selects the focused element among the set of alternatives, leading to an increased difficulty to accept the mentioned alternatives (see also Byram-Washburn, 2013). To bolster this claim the activation of the alternatives would have to be directly compared

to that of the focused element, which was not done here. However, some evidence comes from the main effect of focus found in Experiments 1a and 1b. The stimuli used in Experiment 1a were the same as in Experiment 2 presented here; therefore a direct comparison to the delayed recall task is feasible.

As was outlined, we found that focus particles facilitated the recall of the alternatives but overall the alternatives were remembered less well than the focused elements. We propose that the set of alternatives is further partitioned leaving a special representation for the focused element. This might be a cognitive mechanism to single out the focused element among salient alternatives (see Byram-Washburn, 2013, for a similar argument).

It is further interesting to note that the particles caused interference effects on mentioned alternatives rather than facilitatory effects in the current experimental paradigm. So, the beneficial effects observed in our delayed recall experiments (Chapter 3) were not reflected in decreased reaction times in an immediate recognition memory test. Recognition memory tests are generally easier than recall tests and they impose different task demands (Baddeley *et al.*, 2009, p. 195). Leaving aside these differences, the probe recognition task used here tapped into the process of establishing alternative sets[4], while we investigated the final representation of the focused element and its alternatives in our recall experiments.

The comparison to the delayed recall data suggests that the observed interference effects might not reflect an active dampening (i.e., a suppression) of the mentioned alternatives, since the alternatives are still remembered better later on in the conditions with particles. This finding is most compatible with a competitive inhibition account, assuming that the members of the alternative set compete for a certain amount of activation. We will further discuss this proposal after presenting Experiment 2.

Generally, we are not assuming that no alternatives were activated in the condition without a particle, especially since all conditions bear intonational focus and since we do not have a comparison to an unfocused condition. The claim

[4]The probe recognition task is certainly less online than other measures like for example eye tracking Further, we had an offset of 2050 ms between exposure and test. Note however, that it is common not to present the probe directly in this kind of task (see Gernsbacher & Jescheniak, 1995).

we are making is that there is a relative difference between referencing an alternative set by intonational focus and focus particles. Focal accents evoke a set of alternatives while focus particles establish an association between the focused element and its alternatives. The fact that we did not find any difference between the conditions with *only* and *even* (apart from the marginal interaction in the mentioned alternatives) indicates that what matters is whether or not a particle is present in an utterance. Several studies in our lab did not find any differences between exclusive and additive particles (Experiment 1a, 1b and Experiments 4, 5 and 6 presented in the next chapters) and we note that the interaction observed here was marginal.

Unrelated controls Finally, the null effect in the unrelated control probes (i.e., no RT differences across conditions) indicates that the interference effects were not due to a general processing difficulty associated with the sentences containing particles. For example, one might argue that participants take longer to process the two conditions with particles because they contain an additional word compared to a condition without a particle. Yet, this account predicts different rejection times across conditions for all probes. Hence, we can conclude that the effects of the particles are not due to some general processing difficulties of the sentences with focus particles.[5]

Summary To summarize, Experiment 2 found that the presence of a focus particle in an utterance interfered with the rejection of unmentioned alternatives and the recognition of mentioned alternatives. As a control, the unrelated probes were rejected equally fast across particle conditions. Experiment 2 further indicated that overall the mentioned alternatives were accepted slower than the unmentioned alternatives were rejected, which might be evidence for a general

[5]Another issue could be that the condition with *even* was less felicitous than the other conditions as shown by Rating Study 1 (though much more acceptable than filler items with mild pragmatic violations). We did a correlational analysis with the rating data of the condition with *even* and the RTs of Experiment 2 (averaged across items). There was no significant correlation indicating that the lower ratings did not lead to increased reaction times, neither for mentioned nor for unmentioned alternatives.

inhibitory mechanism by the focused element in the sense of competition inhibition.

4.4 Experiment 3: Activation or inhibition?

The goal of Experiment 3 is to further explore the mechanisms by which alternative sets are construed. In the probe recognition task used in Experiment 3, we found that focus particles interfered with the rejection of unmentioned alternatives (and the recognition of mentioned alternatives). As outlined above, the interference effect of focus particles on unmentioned alternatives could reflect either that unmentioned alternatives are more strongly activated or that there is a greater competition among members of the alternative set in the case of focus particles. We could not clearly distinguish these two possibilities since the probe recognition task required participants to reject the unmentioned alternatives. In Experiment 3, we use a lexical decision task in which participants have to indicate whether a word exists or not, requiring a positive response for mentioned alternatives, unmentioned alternatives and unrelated items. With the lexical decision task, we investigate the nature of the interference effect of focus particles by looking at the relative activation of unmentioned and mentioned alternatives and unrelated items in the presence/absence of a focus particle and not at their integration into the discourse model.

The lexical decision experiment is similar to a number of cross-modal semantic priming experiments in the literature in which participants listen to a sentence and are then presented with a target word for lexical decision. Semantic similarity between prime and target speeds up reaction times (see Swinney *et al.*, 1979, for an early demonstration of the effect) and has been interpreted as evidence that listening to a word activates a cohort of semantically related words (see also Neely, 1977). Priming effects in sentence context depend on a number of factors, including the pattern of activation of competitor words (see especially Norris *et al.*, 2006 for an overview). Interestingly, Norris *et al.* (2006) showed that semantic priming only occurs if an utterance contains a focal accent, pointing to the fact that priming is dependent on intonational focus.

If we assume that listeners activate additional unmentioned alternatives to a focused expression (even if the context lists a set of three elements), we should observe a priming effect for unmentioned alternatives relative to unrelated items, in line with previous findings in the priming literature. If focus particles (i) lead to a stronger competition among members of the alternative set and (ii) unmentioned alternatives take part in this competition, we should again observe an interference effect of focus particles in Experiment 3.

Since several studies of our lab did not find any significant differences between exclusive and additive particles, we excluded the condition with *even* in Experiment 3. Another reason to exclude the third condition was that we had to add pseudowords for the lexical decision task but did not want to extend the duration of the experiment compared to Experiment 2. Experiment 3 hence contains two particle conditions (*only* vs. no particle) and three different target types (mentioned alternative, unmentioned alternative and unrelated target). In line with the priming literature, we refer to the words that participants need to recognize as targets in the lexical decision paradigm (and not as probes as in Experiment 1).

4.4.1 Methods

4.4.2 Participants

Thirty-seven native speakers of German (23 female, 14 male, mean age 25.03 years, age range 18-30) were recruited from a participant pool at the Institute of Psychology of Humboldt University and paid seven Euros in compensation. None of them reported any vision or hearing difficulties. Two participants were excluded from further analyses (one participant had already participated in one of our experiments and the other participant only responded to the comprehension questions but not to the target words). The remaining 35 participants were 14 men and 21 women with a mean age of 24.94 years. All participants were right-handed.

4.4.3 Materials

The materials were exactly the same as those of Experiment 1a and 2, but we only used the condition with the particle *only* and the control condition without a particle and included pseudowords.

The dialogs were paired with the same sets of target words. In total, there were 60 critical trials with an existing German target word spread across two particle conditions and three target types (mentioned alternative, unmentioned alternative and unrelated). A given dialog was repeated twice in a different particle condition paired with a different target word. We did not want to repeat the items three times as in Experiment 2, since we were afraid that participants would stop paying attention to the dialogs. This is more of a problem in a lexical decision task, because participants could solve the task without having processed the discourses. Hence, we only repeated a given item twice and only used two particle conditions (*only*, no particle). We further addressed this issue by posing 30 comprehension questions at unpredictable points. The comprehension questions were only asked in filler items and they appeared with a random distance from two to eight items.

In addition to the experimental items, we used 45 filler items. Twenty filler items existed from Experiment 2 and we added another 25 filler items from another experiment with a narrative item structure (Experiment 1b). The filler items were repeated twice during the course of the experiment with either two different pseudowords or a pseudoword and an existing unrelated word (not used for any of the other items). In sum, there were 75 existing words (60 from the critical trials and 15 from the fillers) and 75 pseudowords (all of which were presented in filler trials). Hence, the expected responses and the ratio between real words and pseudowords was counterbalanced.

The 75 items (30 experimental and 45 filler items) were repeated twice, appearing in each of the particle conditions (*only* vs. no particle) combined with a different target word (mentioned alternative, unmentioned alternative or unrelated). This resulted in a total of 150 trials per participant with ten critical items per combination of particle and target condition. The stimuli were spread across five experimental blocks separated by a short break. Three experimental

lists were created by rotating through the particle conditions and target types according to a Latin square design. A given list was pseudo-randomized for each subject with the program Mix (van Casteren & Davis, 2006). The following constraints were set for randomization: no more than three filler or experimental trials were presented in a row, a given particle condition appeared at most three times in a row. The repetitions of an item were separated by at least 50 trials. Additionally, the expected responses (yes or no) were controlled so that a participant was required to give the same response in no more than four subsequent trials.

4.4.4 Procedure

The basic procedure (timing, etc.) was the same as in Experiment 2. Instead of the probe recognition task, participants were told to judge whether a visually-presented word was an existing word or not. They were explicitly warned not to perform a probe recognition. We also told them at the start of the experiment that they have to listen carefully to the content of the stories and will be asked comprehension questions. Every 30 trials, subjects had a short break. All subjects were tested individually and an entire session lasted about 45 minutes.

4.4.5 Results

Incorrect responses were excluded from further analysis (2.3 %). Responses that were more than two standard deviations from a participant's mean within a given target type and focus condition were discarded (5.7 %). Figure 4.3 shows the mean reaction times across unrelated items, unmentioned alternatives and mentioned alternatives based on the model. We employed the same procedure of model fit as described in Experiment 2. Here, the factor particle was treatment coded, because it only had two levels (*only* vs. no particle). We again chose the unmentioned alternatives as reference level in order to evaluate the difference between unmentioned alternatives and unrelated items as well as between unmentioned and mentioned alternatives.

The interaction between particle condition and target type was not significant ($p = .21$ for alternatives and .95 unrelated items) and did not improve the model

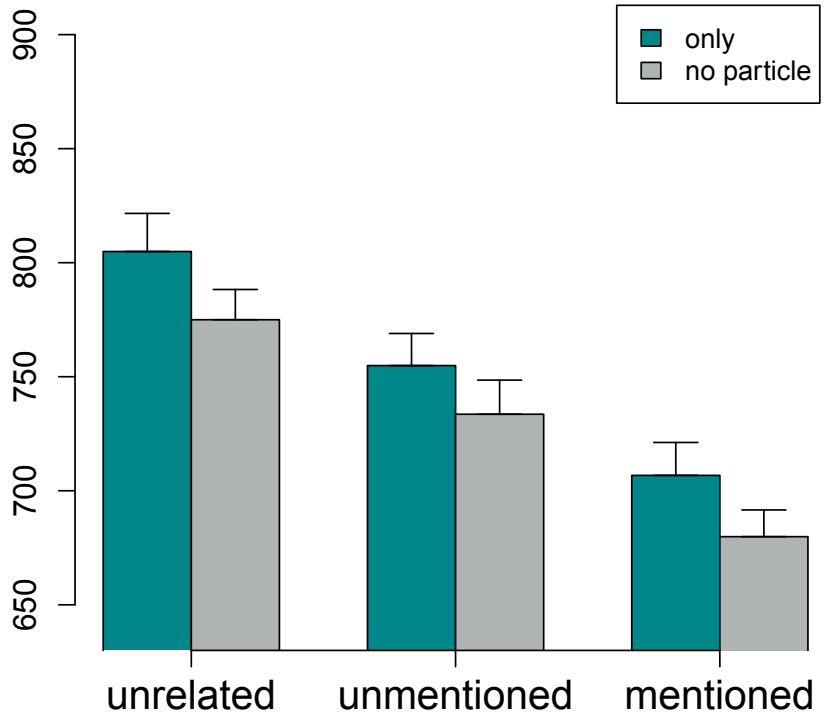

Figure 4.3: Mean RTs of unrelated items, unmentioned alternatives and mentioned alternatives (Exp. 3). Error bars represent standard error

fit ($\chi^2(2) = 1.5$, p = .43). The interaction was therefore not included in the final model. The final model contained the log-RTs, fixed factors for particle condition and target type, random factors for items, subjects and random slopes for trial. Forty-eight additional outliers were removed (2.5 %).

The model revealed that the unrelated items were recognized slower than the unmentioned alternatives (t = -6.54, SE = .009, p <.0001) and that the mentioned alternatives were recognized faster than the unmentioned alternatives (t = 6.04, SE = .009, p <.0001). These two main effects demonstrate priming effects of unmentioned alternatives and additional repetition/identity priming of the mentioned alternatives.

The model further showed that participants' reaction times were overall slower in the condition with *only* compared to no particle (t = 2.13, SE = .007, p <.05). Hence, there was an overall interference effect of the particle *only* in this experiment. Table 4.3 summarizes the model.

Table 4.3: Results of mixed model for Experiment 3 (n = 1888, log-likelihood = 532.8) including estimates, confidence intervals and p-values.

	Estimate	**Lower**	**Upper**	**pMCMC**
Intercept	6.5561	6.5034	6.6080	0.0001
Only	0.0167	0.0018	0.0322	0.0302
Unrelated	-0.0579	-0.0765	-0.0391	0.0001
Mentioned	0.0634	0.0447	0.0831	0.0001
Trial	-0.0016	-0.0020	-0.0011	0.0001

4.4.6 Discussion

Experiment 3 employed a lexical decision task and found an interference effect of the particle *only* compared to the condition without a particle, which was similar across target types. The overall recognition of the different target types showed exactly the reverse pattern of results of the probe recognition task (Exp. 2): the unmentioned alternatives were recognized faster than the unrelated items

but slower than the mentioned alternatives. These findings reveal classic semantic priming effects for the unmentioned alternatives and additional repetition/identity priming effects for the mentioned alternatives.

Such priming effects demonstrate that mentioned as well as unmentioned alternatives become activated, even if the context is limited to a set of three elements. The mentioned alternatives receive the highest amount of activation since they have been mentioned and repeated in the prior context.

The priming effects were present in the condition with *only* and the condition without a particle. One may wonder whether the observed effects are related to alternative sets at all, since no differential priming effects for the particle condition and the control condition were observed in Experiment 3. However, as shown by Norris *et al.* (2006) the presence of focus seems to be crucial for priming effects to occur in sentence context. Hence, the general priming effects were likely due to the fact that our sentence material contained an intonational focus in all conditions.

In Experiment 3, participants did not have to indicate that the unmentioned alternatives had not been mentioned but to simply judge whether they were an existing word or not. We found an interference effect of the focus particle *only* relative to bare intonational focus. This indicates that the competition among members of the alternative set is stronger in the case of focus particles.

We did not anticipate that the interference effect of *only* was equally present in the unrelated items, especially since we did not observe such an effect in Experiment 2. However such a pattern of results was also present in three prior lexical decision studies (Norris *et al.*, 2006, Husband & Ferreira, 2016, Byram-Washburn, 2013, Experiment 1). I will discuss reasons why the unrelated items behaved differently in Experiment 2 and 3 in the general discussion of this chapter.

Considering previous studies on the activation of alternatives by means of contrastive accenting, one might expect to observe facilitatory instead of inhibitory effects when participants are asked to recognize alternatives. Note that the studies by Braun & Tagliapietra (2010) and Husband & Ferreira (2016) never introduced a contextual set of alternatives but tested unmentioned alternatives (without any prior mention of alternatives). Note also that we found significant

priming effects for mentioned and unmentioned alternatives compared to unrelated items, as did these prior lexical decision studies, which demonstrates that the alternatives (mentioned and unmentioned) were activated. Comparing across focus conditions, Braun & Tagliapietra (2010) found stronger priming of (unmentioned) alternatives with L+H* accents (in fact no priming of contrastive associates was observed in the condition with H* accent) while Husband & Ferreira (2016) observed priming effects of similar magnitude in both focus conditions. In our study, the particle *only* caused an interference effect relative to the condition without a particle, which is in line with one of the lexical decision studies by Byram-Washburn, 2013. Such an interference effect was also present in our Probe Recognition Experiment 2. Therefore, what seems to play a crucial role is whether focus is marked intonationally or additionally by a focus particle. I will continue this discussion in the following sections.

4.5 General discussion

Comparison between probe recognition and lexical decision In the probe recognition paradigm employed in Experiment 2, we found that the particles *only* and *even* interfered with the rejection of unmentioned alternatives and the correct recognition of mentioned alternatives. Overall the acceptance of the mentioned alternatives was slowest, the rejection of the unmentioned alternatives was intermediate and the rejection of unrelated items fastest.

In the lexical decision study, the reverse overall pattern was found: the recognition of the mentioned alternatives was fastest, the unmentioned alternatives were intermediate and the unrelated items slowest. These effects demonstrate priming effects for unmentioned alternatives relative to unrelated items and additional repetition/identity priming for the mentioned alternatives. The particle *only* again caused an interference effect compared to the no-particle condition, this time also for unrelated items.

The probe recognition task required participants to create a mental model/ representation of the discourse and to compare a probe word with this representation of the text while this matching was not necessary for the lexical decision task. In addition, the different tasks tap into different processing levels - the

semantic (or conceptual) level and the lexical level, respectively (though we are not claiming that those two levels are completely separate or independent). In the probe recognition task, the unrelated items were more easily rejected than the related probe types (alternatives), because they could be ruled out based on category membership. That is, because the context is not related to the items, participants need not even consider those probes. In a similar vein, Hermann *et al.* (1975) argued that correct recognition of a probe depends on an analysis of multiple dimensions of the stimulus whereas rejection can occur before all analyses are completed. The study by these authors also found a semantic category effect in probe rejection such that unrelated items were rejected faster than related items.

As I argued in the discussion of Experiment 2, I assume that focus particles lead a participant to encode a placeholder sensitive to elements that can be substituted with the element in focus. In the probe recognition task, the interference effects in the rejection of unmentioned alternatives arise because the unmentioned alternatives match the placeholder and participants are required to reject those alternatives. The unrelated items, on the other hand, do not bare any semantic relationship to the context and do not match the placeholder (but see the novel analysis presented in the next chapter).

The lexical decision task, in turn, reveals how present or active a specific word is. To be successful at this task, participants do not even need to compare the target word with the previously-presented discourse (note, however, that they had to pay attention to the stories because comprehension questions were asked in some trials). The differential task demands might account for the overall difference observed between the tasks and possibly for the fact that there was no effect of the particles in the rejection of unrelated probes in Experiment 2. As a consequence, the probe recognition task might be more likely to reveal which elements listeners consider as part of the alternative set compared to the lexical decision task. Gernsbacher & Jescheniak (1995) further argue that probe recognition tasks are a more direct measure of the listener's discourse representation than corresponding lexical decision tasks.

Taken together, the results suggest that focus particles encourage a listener to entertain a set of mentioned and unmentioned alternatives and to trigger a search

through this set. The converging evidence from the two experiments suggests that focus alternatives become activated (even unmentioned ones) and that there is competition among those elements as evident in the interference effects caused by the presence of focus particles.

Encoding-retrieval relationships In our delayed recall experiments, we found that focus particles led to better retrieval of focus alternatives after a delay of about four minutes (with nine intervening discourses). We assumed that this beneficial effect of the particles was due to better encoding of the alternatives. Research on encoding-retrieval-relationships suggest that a greater processing effort at an initial encoding stage can lead to beneficiary effects on the long run (see for example Elmes & Bjork, 1975 for an effect of elaborative rehearsal on retrieval and Hofmeister, 2009 and Drenhaus *et al.*, 2011 for work on focus and encoding-retrieval relationships). A reflection of this is seen in the processing costs observed in the present experiments, which we interpret as a competition among members of the alternative set.

While the focus set is being encoded, activation flows to all elements that could be substituted for the focused expression, even unmentioned alternatives (as observed in the two experiments reported here). We surmise that later the unmentioned alternatives decay in activation and the mentioned alternatives become more salient as evident in our delayed recall experiments. This decay of unmentioned alternatives (and the difference in timing) might account for the fact that Fraundorf *et al.* (2010) did not observe any differences across focus conditions in the rejection of unmentioned alternatives (lures) in their delayed recognition memory experiment. Note that the test session took place one day later. We assume that during the encoding stage, a cohort of semantic competitors is accessed from the mental lexicon and that this set is subsequently narrowed down to the relevant members of the alternative set, in our case the mentioned alternatives (see Rooth, 1985; 1992; Katzir, 2007 and Fox & Katzir, 2011, for specific grammatical mechanisms).

Another aspect is that the truth value judgment paradigm used by Fraundorf and colleagues likely tapped into the inferences (exhaustive implicatures) participants had drawn from the discourses, which are usually based on the relevant

alternatives (more specifically, on the intersection between formal and relevant alternatives: see for example Chemla & Singh, in press in for an overview on mechanisms involved in implicature computation).

There might further be an interesting theoretical difference between contrastive accents and the particle *only*. As was noted in Chapter 2, Molnár (2002) proposes a distinction between a weak exclusion of alternatives with contrastive accent and a strong exclusion with *only* (or other semantic exhaustification operators). From this distinction, it follows naturally that contrastive accents only had an effect in the rejection of the mentioned alternatives, because no claim about the exclusion of other alternatives is made by a contrastive accent. *Only*, on the other hand, makes a much stronger statement namely that no other alternative than the focused element leads to a true assertion. The particle *even*, on the contrary, presupposes that the predication is true for at least one of the alternatives.

Activation and inhibition Recent research suggests that generating a set of alternatives in online processing might involve facilitation and inhibition of the alternatives at different points in time (Husband & Ferreira, 2016, and Byram-Washburn, 2013).

This assumption is consistent with the current data. We propose that alternative sets are established by initial activation of mentioned and unmentioned alternatives, even when the context is restricted to a set of elements. By competitive inhibition the relevant alternatives become salient. This inhibition does not seem to reflect an active suppression mechanism since we found priming effects for mentioned alternatives and unmentioned alternatives. Moreover, the mentioned alternatives were remembered better in the conditions with focus particles in our delayed recall experiments (see Chapter 3). The fact that the acceptance of the mentioned alternatives was slowest in the probe recognition paradigm might further indicate that the focused element takes part in this competition interfering with the acceptance of the salient alternatives (which is in line with previous research showing a privileged representation of focused elements). Overall, we suggest that the observed interference effects are due to competition among the elements in the alternative set, involving the focused element and mentioned as

well as unmentioned alternatives. This competition among members of the alternative set is stronger in the case of focus particles because they establish a strong association with focus (Beaver & Clark, 2008, see also the end of this section).

According to alternative semantics (e.g.,Rooth, 1985; Rooth, 1992), focus marking by intonational means introduces an additional focus semantic value that evokes expressions that can replace the focused element. Focus particles establish an association with a focused expression and they require a salient set of alternatives by their conventional meaning while intonational focus marking does not have a truth-conditional impact. In the stimuli we used here, the set of alternatives was signaled by multiple information-structural cues by focus accenting and by focus association with a particle. Note that we did not vary the presence or absence of focus per se in the present series of experiments nor did we manipulate the pitch accent type on the focused expression (contrastive or non-contrastive). Even with the same pitch accent type on the focused element in all experimental conditions, we observed an impact of the particles on the participants' probe recognition times.

Interestingly, we again did not find any differences across the different types of focus particles in our experiments. Experiment 2 compared the exclusive particle *only* with the scalar particle *even* and the two conditions did not differ significantly, which was corroborated by the experiments presented in Chapter 3. This lack of difference does not mean that the different particles can be interchanged randomly in an utterance or that they carry exactly the same meaning. However, the task we used here required participants only to recognize a visually presented probe or target and did not introduce any further manipulations (see, e.g., Kim, 2012 and Gotzner & Spalek, 2014; who found differences between *only* and *also*). As far as we can tell, the specific meaning components of the particles did not seem to have played a role in these tasks. Hence, it was the presence (vs. absence) of the focus particles that caused the observed effects. Therefore, the crucial factor that influences encoding and retrieval of focus alternatives tasks seems to be the conventional association with focus alternatives (Beaver & Clark, 2008) established by focus particles.

Conclusion To conclude, the two experiments presented in this chapter show that focus particles lead participants to activate and compare mentioned alternatives, unmentioned alternatives and the focused element. The study demonstrates that listeners entertain a set of alternatives upon processing focus particles and that focus particles interfere with the recognition of alternatives, indicating a stronger competition among elements of the alternative set. The study thereby provides further evidence for the psychological reality of the alternative semantic account of focus (particles) developed in Rooth (1985, 1992).

4.6 Chapter summary

Experiments 2 and 3 showed that upon processing focus particles, a set of unmentioned alternatives is activates even when the context already lists a set of elements. The enumerated alternatives receive the highest activation but interestingly the are recognized slowest in a probe recognition paradigm. These results show that focus particles encourage deeper encoding of the alternative set involving a cohort of multiple semantic competitors. We observed additional interference effects by focus particles indicating that the competition among elements of the alternative set is stronger in the case of focus particles.

Chapter 5

What's included in the set of alternatives?

The fifth chapter examines which elements are included in the set of alternatives in more detail. I will compare a so-called permissive view as proposed by Rooth (1992) to a more restricted view assuming that certain alternatives are excluded from consideration. I will present a further analysis of the unrelated items of Experiment 3, distinguishing whether those items were possible replacements of the focused element or not. Experiment 4 compares alternatives to general non-contrastive associates of a focused expression.[1]

5.1 Permissive vs. restrictive view

The function of focus is to evoke a set of alternatives. However, it is an open theoretical question which elements are included in the alternative set and at which level restriction applies. In the proposal by Rooth (1992) the formal set of alternatives contains various possible replacements and restriction applies at the level of pragmatics (independent of compositional semantics).

In his paper *A note on contrast*, Katzir (2013) compares this permissive standard view to a more restrictive one. I will follow Katzir (2013) in using the terms

[1] I designed the additional analysis presented in Section 5.2 as well as Experiment 4 and analyzed all results. A version of Section 5.2 will appear in the Proceedings of *Sinn und Bedeutung* (Gotzner, 2015).

permissive and *restrictive*. One version of a restrictive account was proposed by Wagner (e.g., Wagner, 2006, Wagner, 2012), who assumes that certain alternatives are systematically excluded from consideration. His proposal is based on examples such as the ones in (1) listed below (taken from Wagner, 2006).

(1) a. John only owns $[\text{red}]_{\text{F}}$ convertibles
b. John only owns $[\text{blue}]_{\text{F}}$ convertibles
c. John only owns $[\text{cheap}]_{\text{F}}$ convertibles

Wagner points out that the sentence *John only owns red convertibles* excludes/negates that John owns blue convertibles but does not necessarily state anything about cheap convertibles. Therefore, Wagner proposed that only those elements that are mutually exclusive are part of the alternative set (in the given example, *red* and *blue* but not *red* and *cheap*). His account relies on the assumption of contrast between elements of the alternative set.

In Rooth (1992), on the other hand, the adjective *cheap* would be part of the alternative set for the given sentence, because it is a possible replacement of the focused element *red*. Further, no notion of contrast is assumed: the focused expression does not need to contrast with its alternatives in the sense that, if the focused element is true, the alternative need to be false (see also Büring, 2008 for a discussion of this point). Rather the alternatives match the focused expression in type. Katzir (2013) showed that the permissive view makes the correct predictions for examples such as the ones above, when the contradiction between elements is eliminated (for example by using a different verb in the sentence).

Here, we take a psycholinguistic approach to explore the question which elements are included in the alternative set. The aim of following analysis and experiment is to see which account makes better empirical predictions concerning the activation/retrieval of alternatives. The experiments presented in the last chapter have provided some evidence for the permissive view: the lexical decision study showed that a cohort of semantic competitors is available to the listener. That is, even though a set of three elements was listed in the context additional unmentioned alternatives became activated. The probe recognition experiment further showed that interference effects of focus particles arise for mentioned as

well as unmentioned alternatives. These results are consistent with the permissive view, assuming that various elements form part of the alternative set and take part in the competition process.

The novel analysis presented in Section 5.2 more closely examines the unrelated items used in Experiments 2 and 3, comparing whether those items could potentially replace the focused element or not. Experiment 4 uses a context that only mentions a semantic category and further seeks to investigate what elements are being considered as alternatives by comparing alternatives to general associates of a focused expression.

5.2 Effect of focus on unrelated items

Strikingly, in Experiment 3 a set of three elements was listed in the context but still additional unmentioned alternatives became activated. This suggests that multiple possible replacements are part of the set of alternatives. One might argue that the activation of unmentioned alternatives was based on general semantic priming mechanisms (because all items were related) and does not have anything to do with the computation of/access to alternatives. The effect of *only* ameliorates this concern but to inform the permissive/restrictive debate we would like to "eliminate" the relatedness factor. A restriction argument could be made for the unrelated items used in Experiment 3. For example, the sentence *Anna only bought apples* excludes/negates elements like *pears* but it might not necessarily make a statement about other types of things Anna could have bought like *socks*. In other words, on the restrictive view an unrelated item like *socks* might not be part of the alternative set. On a permissive view, it would be included in the alternative set, since it is a possible replacement of the focused element *apples*.[2]

Another aspect about the unrelated items used in Experiment 3 was that we found interference effects of the particle *only* similar to interference effects on related items. We did not anticipate such an effect, however an effect of focus on unrelated items was also present in some prior lexical decision studies (e.g., Husband & Ferreira, 2016, Byram-Washburn, 2013). A closer inspection of the

[2]Note, however that we are not investigating mutually exclusive alternatives on which the account by Wagner (2006) is based on.

targets used in these studies shows that Braun & Tagliapietra (2010) used unrelated items that could replace the focused expression whereas in Husband & Ferreira (2016) the unrelated items could not replace the focused elements. In Byram-Washburn (2013), the unrelated items resembled our unmentioned alternatives (and were possible replacements). In our Experiment 3, about half of the items were possible replacements while the other half were not. Consider the two examples displayed below:

(2) a. Possible replacement: Matthias has bought [trousers]$_{\mathrm{F}}$. Matthias has bought x, x = LYCHEES

b. No replacement: Carl has caught [flies]$_{\mathrm{F}}$. Carl has caught y, y = SOFAS

According to alternative semantics, the grammatical set of alternatives (focus semantic value) is derived by substituting the focused elements with elements of the same semantic type. This implies that unrelated items could be part of the alternative set, if they are possible replacements. Note that the theory does not necessarily state that the elements of the alternative set are part of the same taxonomic category. For example, imagine a scenario of a shopping list with shower gel, apples and bread. If somebody says *Peter only bought bread*, he asserts in this context that Peter did not buy shower gel even though these items are not part of the same taxonomic category. In that sense, elements of the same semantic type (of the form *Peter bought x*), which are not necessarily taxonomic elements, function as alternatives to the focused element. Importantly, however, the unrelated items used in Experiment 3 were note listed in the context (see especially Byram-Washburn, 2013 concerning non-taxonomic elements, which are mentioned together in the context).

In the analysis presented below I coded our unrelated items according to whether they were possible replacements of the focused element or not. I included this binomial factor in the analysis of the lexical decision data. The purpose of the analysis is to see whether the unrelated possible replacements are considered as part of the alternative set. A second goal was to explore whether the effects

of focus particles were only present for possible replacements.[3]

5.2.1 Coding

The items were coded by three persons, a trained research assistant, a naïve native German speaker and myself. Only those items, where judgements of the three coders converged were included in the analysis. Sixteen of the target words were possible replacements, eleven were not and three could not be clearly categorized. This additional variable (possible replacement: yes/no) was included in the analysis.

5.2.2 Results

Figure 5.1 shows the mean RTs across particle condition and target type. The left column presents items that could not replace the focused element and the right column shows possible replacements.

We fit a series of mixed models with the same factors and random factors as in the previous analysis and the additional binomial factor replacement/non-replacement. The possible replacements were chosen as baseline level (in the condition without a particle of the unmentioned alternatives as before). We only included an interaction term of the factors replacement and target type. The three-way interaction between particle condition, replacement and target type did not contribute to model fit ($\chi^2(5) = 7.18$, p = .20) and was therefore not included in the final model. Fifty outliers were removed from the final model.

Main effects of particle condition, target type and replacement The main effect of *only* was not significant (p = .13), probably due to the fact that were less items and observations in this model. There was a significant difference between unmentioned and mentioned alternatives (t = -5.67, SE = .013, p

[3]Since effects of focus particles on unrelated items were only observed in lexical decision experiments (but not in Probe Recognition Experiment 2), we only carried out such an additional analysis for Experiment 3.

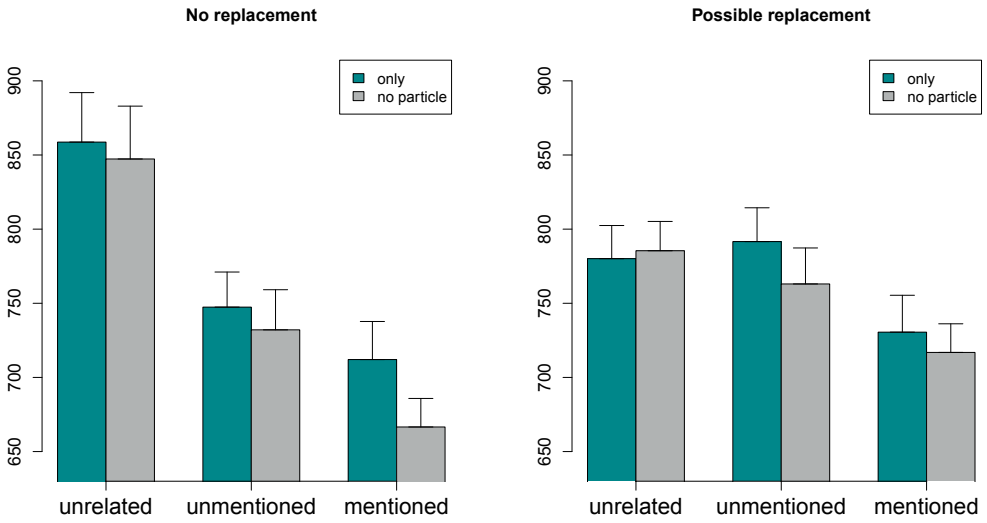

Figure 5.1: Mean RTs of possible replacements (left) and non-replacements (right) (Exp. 3). Error bars represent standard error.

<.0001). Interestingly, the difference between unmentioned alternatives and unrelated items was not significant (p = .74), indicating that possible replacements were recognized equally fast as unmentioned alternatives.

We were specifically interested in the effect of the variable replacement. The model revealed a main effect of the variable replacement: possible replacements were recognized faster than non-replacements (t = -2.49, SE = .029, p <.05).

Interactions between target type and replacement Critically, there was also an interaction between the unmentioned alternatives and unrelated items concerning the factor replacement (t = 7.78, SE = .02, p <.0001). This interaction indicates unmentioned alternatives differed significantly from unrelated non-replacements but not from possible replacements. Finally, there was an interaction between mentioned alternatives and unmentioned alternatives concerning the replacement factor (t = 2.2, SE = .02, p <.05) reflecting that the difference between mentioned and unmentioned alternatives was bigger for items categorized as possible replacements. This interaction might be due to the fact that the

data set was not perfectly balanced (there were 16 possible replacements and 11 non-replacements) but this interaction should not be of theoretical interest.

Table 5.1: Results of mixed model for replacement analysis (n = 1696, log-likelihood = 484.2) including estimates, confidence intervals and p-values.

	Estimate	**Lower**	**Upper**	**pMCMC**
Intercept	6.5931	6.5343	6.6479	0.0001
Only	0.0121	-0.0039	0.0283	0.1396
Mentioned	-0.0742	-0.1007	-0.0480	0.0001
Unrelated	-0.0047	-0.0303	0.0218	0.7444
Non-replacement	-0.0727	-0.1271	-0.0155	0.0106
Trial	-0.0016	-0.0021	-0.0011	0.0001
Mentioned:non-repl.	0.0444	0.0033	0.0853	0.0326
Unrelated:non-repl.	0.1609	0.1179	0.2006	0.0001

The results of the mixed model are displayed in Table 5.1. Descriptively, the effect of *only* seems to be less robust in the unrelated items while it remains similar in the mentioned and unmentioned alternatives (compared to the overall analysis of Experiment 3 presented in the last chapter). However, since there was no significant interaction between particle condition and target type no strong claims can be made about this difference.

5.2.3 Discussion

The additional analysis of the lexical decision data (Exp. 3) showed that unrelated possible replacements of the focused elements were as active as unmentioned semantically-related items (unmentioned alternatives). It further showed a main effect of the variable replacement such that unrelated non-replacements were recognized slower than possible replacements. Note that the unrelated items were not mentioned in the context sentences. Nevertheless, the additional analysis presented here indicates that listeners were sensitive as to whether or not an unrelated item could potentially replace the focused element in the previously-presented discourse.

These effects provide evidence in favour of the permissive account of alternative sets (e.g., Rooth, 1992). The data suggest that even unrelated items are part of the alternative set if and only if they are a possible replacement of a focused expression. This is exactly what the permissive view predicts. On the restrictive view, on the other hand, those unrelated items might be excluded from consideration and there is no reason why those elements should be activated *per se*. For example, they do not form part of the same semantic network and they are not related to the context either. In sum, the experiments favour a theory in which a formal set of alternatives contains various possible replacements instead of a theory where restriction applies locally/semantically (see for example Umbach (2001) and Umbach, 2004 for a detailed discussion on restriction).

We do not dispute that the alternative set is restricted/limited in some way. However, listeners seem to consider a larger set of alternatives rather than a limited one (e.g., consisting of only the contextually-provided alternatives). Note that we are not claiming that all those items are in the focus of attention of a listener. Rather the claim is that activation spreading is broad rather than limited. To validate the restrictive view proposed by for example Wagner (2006) it would be important to set up the experiment so that target items are either mutually exclusive or not. Hence, we cannot rule out this specific account based on the present data. Yet the data are more consistent with the permissive view proposed by Rooth (1992). More specifically, the data indicate that elements, which can be substituted for a focused expression are considered as alternatives, even when such elements are not related to the focused expression or mentioned in the context. Byram-Washburn (2013) further provided evidence that by contextual mention previously unrelated items can form part of an alternative set.

Concerning the effect of focus particles on unrelated items we cannot derive any claims from the current analysis since we did not observe a significant interaction between the factors particle condition, target type and the replacement variable. Future psycholinguistic studies on the activation of alternatives should carefully control unrelated items, especially when priming effects are assessed relative to a baseline with unrelated items. The analysis presented here indicates that whether or not unrelated items are potential replacements of the focused

element is a crucial factor. The replacement variable might therefore be another potential moderator accounting for the differences observed across experiments.

5.3 Experiment 4: Contrastive vs. general associates

I have argued that alternative sets are established by semantic activation and competition among those elements. The analysis presented above suggests that even unrelated items to the focused element are activated if they are a possible replacement of the focused element. The effects of focus (particles) on the related items (i.e., mentioned and unmentioned alternatives) observed in the previous experiments could be based on more general semantic networks with no particular reference to formal alternatives. Alternatively, such effects might be selective to those associates that are possible replacements (i.e., formal alternatives).

As was pointed out in section 2.2.2.1, previous psycholinguistic studies have provided mixed results regarding this question. In particular, it is unclear whether establishing alternative sets also relies on activation of non-contrastive associates to some extent. The study by Braun & Tagliapietra (2010) found priming of contrastive alternatives but no differential effect of contrastive prosody on general non-contrastive associates of a focused expression. Hence, the study suggests that focus does not play a special role in the activation/inhibition of non-contrastive associates. Husband & Ferreira (2016), on the other hand, claimed that initially all associates of a focused expression become activated and that the non-contrastive associates have to be rejected in a later step. In fact, the activation of non-contrastive associates was stronger/present earlier if the focused elements were contrastively-accented.

According to alternative semantics, the grammatical set of alternatives is derived by substituting the focused elements with elements of the same semantic type. Accordingly, we would predict that only contrastive associates are being considered as part of the alternative set but not general associates (since the way the studies were set up, general associates cannot replace the focused element).

Experiment 4 compares associates (related items) of a focused expression that are possible replacements or not. For example, in the sentence *Peter only bought bread* a word like *baker* is a non-contrastive associate of the focused word *bread* since bakers make bread. It is, however, not an alternative, because it cannot be substituted for *Peter bought x*. Based on this logic, we do not expect to see interference effects of focus particles in the reactions towards non-contrastive associates.

It might be that non-contrastive associates become generally activated through semantic activation spreading, which is measured by the lexical decision task. However, those elements should not be considered as part of the alternative set. As was argued in the last chapter, the probe recognition task might be more likely to reveal which elements participants actually consider as part of the alternative set compared to the lexical decision task. Therefore, we use the probe recognition paradigm in Experiment 4.

A further goal of the experiment was to see whether similar mechanisms apply when no explicit set of alternatives is listed in the context. In ordinary conversation, speakers often do not provide a listener with an explicit set of alternatives, rather this set needs to be reconstructed from the context. We expected to see similar interference effects of focus particles, even if the alternatives remain implicit. We provided participants with a semantic category and an exemplar of this category as the focused element. Then, we asked them to reject an associate of the focused element that was either an alternative (contrastive) or a non-contrastive associate. As in Experiment 2, we take reactions to indicate whether participants consider a certain element as an alternative. Crucially, reactions towards non-contrastive associates (in a probe recognition paradigm) should not differ across particle conditions.

In this experiment, we used the particle *also* (German 'auch'), which might be a better comparison to *only*, because it lacks the additional scalar presupposition *even* has. Based on our previous experiments, we again predict no differences between particle conditions.

5.3.1 Methods

5.3.1.1 Participants

A total of 24 native speakers of German (15 female and 9 male, mean age 26.1 years, age range 22-30) were recruited from a subject pool at the Institute of Psychology of Humboldt University and were paid seven Euros in compensation. None of them reported any vision or hearing difficulties.

5.3.1.2 Materials

60 discourses were created that consisted of three sentences following the structure in (3). A complete list of the critical items is found in Appendix A.3. The first sentence (context sentence) mentioned a person, an action and a semantic category. The second sentence (critical sentence) either contained (a) the exclusive particle *nur* ('only'), (b) the inclusive particle *auch* ('also'), (c) or no particle. It referred to an exemplar of the category. The final sentence was a filler sentence that kept the person foregrounded and did not mention any exemplars of the category. There was no correction in the critical sentences. An additional filler sentence was added after the critical sentences. See the example shown below:

(3) **Context sentence:**
Carsten wollte gern Obst essen und griff in einen Korb
'Carsten wanted to eat some fruit and reached into a basket'
Critical sentence:
(a) Er nahm sich nur [Äpfel]$_{F}$ heraus
(b) Er nahm sich auch [Äpfel]$_{F}$ heraus
(c) Er nahm sich [Äpfel]$_{F}$ heraus
'He (a) only/ (b) also/(c) _ took out [apples]$_{F}$ out of it'
Filler Sentence
Er ernährte sich stets ausgewogen
'He always lived on a balanced diet'

The critical sentences were spoken with a falling accent on the focused element. The particle was not accented this time, because this would lead to a different reading (subject focus) in the case of *also* (see for example Krifka, 1998). Figure

5.2 shows the average pitch contour of the focused expression across all experimental items. As can be seen from the Figure, the accent type was again constant across conditions.

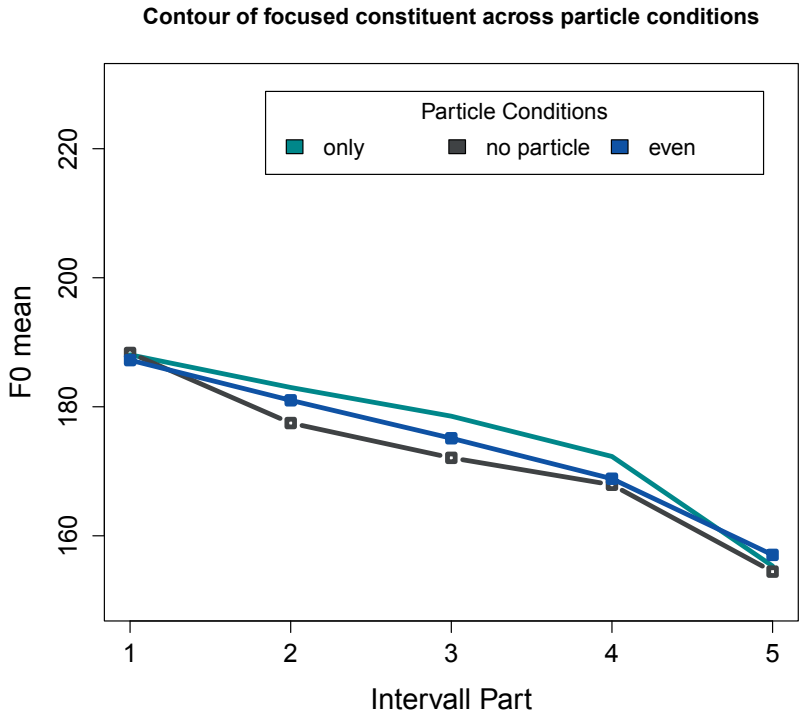

Figure 5.2: Mean pitch contour of the focused element in Experiment 4

Each discourse was paired with two probe words: a contrastively-associated probe and a non-contrastively-associated probe (see Appendix A.6). The contrastive probes were nouns that could be grammatically substituted for the focused nouns and that belonged to the semantic category mentioned in the context sentence (e.g., *berries* in example (3)). The non-contrastive associates were nouns that were related to the focused words by world knowledge or part-whole relation (e.g., *maggots*). Crucially, they did not belong to the same taxonomic category as the focused element and could not be substituted in the same position. The logic of this comparison was the same as in Braun & Tagliapietra (2010) in that we expected that focus particles would interfere with the rejection of contrastively-

associated nouns but not with the rejection of non-contrastive associates because they do not serve as alternatives to the elements in focus.

An online pretest that compared the association strength of the two probe types with the focused words was administered to 20 native German subjects. The items were split across two lists in a Latin square design so that a participant judged a given item only in one of the conditions (as was the case in the main experiment). The judgements indicated that the association strength was comparable for contrastively-associated (5.4 on a 1-7 Likert scale) and non-contrastively-associated probes (5.7). We analyzed the judgements with a between item ANOVA revealing no significant differences across conditions ($F_{(1,119)}$ = 2.14, p >.1). Two probes that received a low value (2.5 mean association strength out of 7) were replaced and we compared frequency and length of the final list of items across conditions. Univariate ANOVAs showed that the probes were of comparable length and normalized frequency. Table 5.2 summarizes the mean values, standard errors and F statistics of each of the factors.

Table 5.2: Word length and frequency of contrastive and non-contrastive probes.

Probe/Measure	**Contrastive**		**Non-contrastive**		$\mathbf{F_{(2,118)}}$	**p**
	Mean	*SE*	*Mean*	*SE*		
Numb. of Letters	6	0.13	6.13	0.14	0.24	0.79
Norm. Frequency	6.35	0.18	6.89	0.14	0.06	0.95

The expected answer was always *no* on the critical trials (60 with 30 contrastive and 30 non-contrastive associates) since the critical probes had never been mentioned in the discourses. To counterbalance yes- and no-responses, a set of 50 filler items was constructed and 80 additional items from another experiment (Experiment 5) were interspersed with the test items resulting in a total of 190 trials. In the filler trials (130), the probes were nouns from various syntactic positions of any of the sentences. 95 of the filler trials required a yes-response and 35 a no-response so that the overall proportion of yes- and no-responses was 50 % each.

Each subject was exposed to all 60 critical items and 130 filler items. For a given subject, 30 of the critical items were paired with a contrastive probe and the other 30 items with a non-contrastive probe. The items were rotated through the particle conditions and the probe type variable according to a Latin square design. This resulted in a total of six lists that were again pseudo-randomized for each participant with the program Mix (van Casteren & Davis, 2006). The following constraints were set for randomization: no more than three filler or test trials were presented in a row, the particle condition appeared only twice in a row and the expected response was the same in no more than three subsequent trials.

5.3.1.3 Procedure

The procedure was the same as in Probe Recognition Experiment 2. Participants first heard a discourse over headphones and with an offset of 2000 ms a probe word appeared on the screen. The items were distributed over 6 blocks and every 33 items subjects could take a short break. One experimental session lasted about 50 minutes. This time, half of the participants pressed the left button to indicate that the probe had appeared and half of them the right button to indicate a positive response (and vice versa for the negative responses).

5.3.2 Results

Trials in which subjects responded incorrectly were discarded (2.2 %). Fig. 4.3 shows the mean RTs across probe types (left: contrastive, right: non-contrastive). The same procedure of model fit was carried out as in previous experiments. We analyzed contrastive probes and non-contrastive probes separately. Note that this is legitimate because difference across the two probe types were predicted *a priori*.

Contrastive probes The final model for the contrastive alternatives contained the RTs as dependent measure, particle condition, probe type as fixed factors and subject, item, trial as random factors as well as random slopes for trial. No log transformation was performed because this led to a worse distribution of fitted

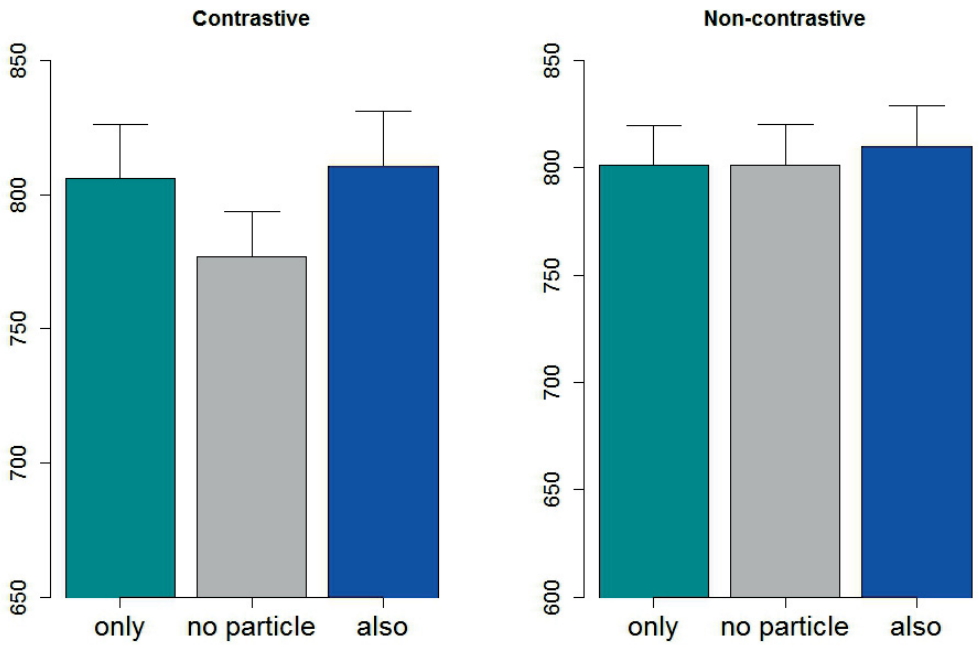

Figure 5.3: Mean RTs for contrastive (left) and non-contrastive probes (right) (Exp. 4). Error bars represent standard error.

values and residuals. Twelve outliers were removed. The model showed that the rejection of the contrastive associates was slower in the condition with *only* (*only* vs. no particle: t = 2.67, SE = 15.9, p<.01) and in the condition with *also* compared to control (*also* vs. no particle: t = 2.15, SE = 15.7, p<.05). Hence, rejection times again increased if the stimuli contained a focus particle. The extent of the interference effect was not significantly different in the two conditions with particles (post-hoc comparison between *only* and *also*). The results of the model are detailed in Table 5.3.

Table 5.3: Results of mixed effects model for contrastive probes in Experiment 4 (n = 686, log-likelihood = -4556) including estimates, confidence intervals and p-values.

	Estimate	**Lower**	**Upper**	**pMCMC**
Intercept	779.30	721.00	844.45	0.0001
Only	42.69	9.05	74.26	0.01
Even	33.84	1.21	65.31	0.04
Trial	-0.77	-1.19	-0.36	0.0001

Non-contrastive probes As a control, we analyzed the RTs across conditions for the non-contrastive associates. Fifteen outliers were removed from the model. The model did not reveal any significant differences across particle conditions (*only* vs. no particle: p = .5; *also* vs. no particle: p = .9). Details of the mixed effects models are found in Table 5.4.

5.3.3 Discussion

In Experiment 4, participants were exposed to items that mentioned a semantic category but did not enumerate the alternatives individually. In the critical sentences, an element of the introduced category was specified (the focused element) and the sentences either contained the particle *only*, *also* or no particle. In the conditions with focus particles (*only* or *also*), the participants' speed to indicate

Table 5.4: Results of mixed effects model for non-contrastive probes in Experiment 4 (n = 696, log-likelihood = -4624) including estimates, confidence intervals and p-values.

	Estimate	**Lower**	**Upper**	**pMCMC**
Intercept	811.50	746.99	876.89	0.0001
Only	-10.01	-42.14	23.08	0.56
Even	1.57	-30.52	34.04	0.94
Trial	-0.96	-1.40	-0.49	0.001

that contrastively-associated probes to the focused elements had not appeared in the story decreased. In contrast, no reaction time differences across particle conditions were seen when participants rejected non-contrastively associated probes. Therefore, the results of Experiment 4 indicate that listeners entertain contrastive alternatives even if the context does not provide an explicit set. Hence, explicit mention is not necessary for listeners to construct an alternative set.

Importantly, the particles did not affect the rejection of non-contrastive associates. As noted above, it might be that non-contrastive associates of the focused elements become activated as well. However, the rejection of these probes should not be influenced by the presence of a particle. This indicates that non-contrastive associates do not take part in the competition among members of the alternative set. If we assume that focus particles lead to the activation of elements that can be substituted for the expression in focus, i.e. alternatives by definition, we should observe exactly this selective effect. We can, therefore, conclude that alternative semantics makes the correct prediction in that listeners only consider possible replacements as alternatives. Experiment 4 further confirms that the observed interference effects we observed are due to the computation of/access to alternatives.

5.4 General discussion

There is one important caveat to the argument about possible replacements presented here. The distinction we and previous studies made between possible replacements and non-replacement was not purely based on syntactic considerations or semantic type match (as suggested by the Roothian framework) even when considering the unrelated items of Experiment 3.[4] Arguably objects like *trousers* and *lychees* are formally of the same semantic type ($< e, t >$) and they both denote objects in the world. Further, in some examples the verb we used might put further restrictions on the required semantic type. However, in most cases to determine possible replacement some world knowledge was required[5]. It might be generally questionable whether psycholinguistic tasks like the lexical decision task can distinguish between semantic and pragmatic knowledge. But in principle, it is possible to construct an experiment that makes exactly those distinctions (see Chapter 7 for further discussion). For example, it might be worthwhile to investigate examples involving different types of adjectives that are mutually exclusive as discussed by Wagner (2006).

The results presented in this chapter suggest that whether or not an item can replace the focused element is a crucial factor in the establishment of alternative sets. It further seems that various possible replacements of a focused element become activated even when the context introduces a limited set. This is in line with the alternative semantic account by Rooth (1985, 1992). The data presented here might further suggest that world knowledge influences which alternatives are used in computation (see Cohen, 1999 for a proposal in this flavour). Interestingly, Experiment 4 showed that focus particles only interfere with the rejection of possible replacements but not with general semantic associates of a focused expression. Overall, the experiments presented here might be an important step to derive an algorithm that determines alternatives.

[4] In Braun & Tagliapietra (2010) most contrastive targets were of the same semantic type as the prime words but some of the items used by Husband & Ferreira (2016) compared entities of different semantic types (e.g., SCULPTOR and STATUE).

[5] I am grateful to Brian Leahy for discussing this with me.

5.5 Chapter summary

To summarize, the additional analysis presented in Section 5.2 as well as Experiment 4 demonstrate that the set of alternatives is cognitively real and favour a permissive rather than a restrictive view of this set. Unrelated items are part of the alternative set (become activated), if they are a possible replacement of the focused element. Importantly, however, Experiment 4 showed that non-contrastive semantic associates of a focused expression are no semantic competitors. This confirms the prediction by alternative semantics: Only those elements that can replace the focused element are considered as alternatives. Experiment 4 further showed that interference effects even evolve when the context does not enumerate the alternatives individually. Thus, listeners seem to infer sets of alternatives based on the semantics of focus particles and intonational focus.

All experiments presented so far have manipulated the presence or absence of exclusive or additive particles. The focused element appeared in object position and carried the same pitch accent across conditions, an H* accent on the accented syllable with varying prominence (with an overall falling contour). In the next chapter, I will more closely examine the role of the pitch accent of the focused element and the way accent types might interact with the different types of focus particles.

Chapter 6

Contrastive pitch accents and focus particles

The sixth chapter looks at the role of the pitch accent type of the focused element and the combination of focus particles with a contrastive accent. In Experiments 5 and 6, I investigate the recognition of mentioned alternatives across different accent types, contrastive and non-contrastive ones. In addition, I explore how the combination of two information-structural cues (contrastive pitch accenting and focus particles) affects the retrieval of alternatives. I have already noted in the last chapter that timing seems to be a crucial factor. Therefore, Experiment 5 incorporates temporal delay as a variable in the experimental setup. Experiment 6 introduces a longer temporal delay by including a numerical distractor task.[1]

6.1 Comparison of previous experimental results

There is evidence from lexical decision studies and delayed recognition memory paradigms that contrastive pitch accents make contextual alternatives more available (e.g., Braun & Tagliapietra, 2010, Fraundorf *et al.*, 2010). In the previous chapters of this thesis, we have seen that focus particles lead to better delayed recall of mentioned alternatives and that they activate a cohort of semantic competitors, leading to interference effects in the recognition and rejec-

[1]Experiment 5 appeared in the Proceedings of the Cognitive Science Society (see Gotzner *et al.*, 2013). All experiments in this chapter were designed and analyzed by myself.

tion of alternatives. Bringing together these studies, the question arises as to whether contrastive pitch accents and focus particles have the same effect on the retrieval of alternatives. As I have argued in Section 4.5, it seems that focus particles cause effects in addition to the effect intonational focus seems to have on the retrieval of alternatives. But let us first compare the experimental results concerning contrastive pitch accents and focus particles in more detail.

Comparing our delayed recall experiments (Exp. 1a and 1b) to the delayed recognition memory experiments by Fraundorf *et al.* (2010), it seems that, at longer delays, both focus particles and contrastive accenting induce similar effects in that they lead to deeper encoding of the alternative set. However, when looking at experiments with more immediate testing points, the evidence is mixed.

Braun & Tagliapietra (2010) and Husband & Ferreira (2016) found an immediate facilitation (with an offset of zero ms) of focus alternatives relative to unrelated items in sentences with contrastive accents. In their experiments, neither target item was mentioned before, only a focused item was present in the prior discourse. In Braun & Tagliapietra's experiments, the priming effect of alternatives was only present when the sentence had been pronounced contrastively compared to neutral. In Husband & Ferreira's study, however, no such interaction was present. Byram-Washburn (2013) compared a contrastive accent with a neutral intonational contour in a mousetracking experiment. She found an inhibition of unmentioned semantic alternatives by contrastive accents.

The two lexical decision experiments with focus particles by Byram-Washburn (2013) provided mixed results. In Experiment 1, she used written materials and provided a set of three elements in the context. She compared a condition with the particle *only* to a condition without a particle. The first experiment revealed a priming effect for newly-associated items compared to unrelated items and a facilitatory effect of the focus particle (compared to the condition without a particle). However, there was no priming effect for semantic alternatives. Further, the focus particle did not cause any significant effect on the recognition of semantic alternatives. In Experiment 2, she used auditory materials and compared a de-accentuated condition to a condition with *only* (bearing a contrastive accent on the particle) and a condition with a bare contrastive accent. The context mentioned an element twice but the target word was unmentioned. Byram-Washburn

found that the semantic alternatives were recognized slower in the condition with *only* compared to the de-accentuated condition. The contrastive accent patterned intermediate between the de-accentuated condition and the condition with *only* but it did not differ significantly from any of the other conditions.

Experiments 2, 3 and 4 of this thesis found interference effects of focus particles relative to a condition without a particle. In Experiment 3, we used a lexical decision task which measured the activation of alternatives relative to unrelated items. This comparison revealed that mentioned and unmentioned alternatives were activated in sentences with and without focus particles. In sum, I interpreted these results as indicating that focus particles cause a stronger competition among members of the alternative set.

Generally, there are two possibilities of how the representation of alternatives unfolds over the course of time. The first possibility is that the alternatives are first inhibited, possibly reflecting a processing cost of choosing the members of the set (Byram-Washburn, 2013, p. 128). Subsequently, those selected members are facilitated or become salient. I will refer to this hypothesis as the initial inhibition hypothesis. The second possibility is that the alternatives are first activated/facilitated and inhibited in a subsequent step. I will call this hypothesis the initial activation hypothesis.[2]

Comparing the previous studies, studies manipulating contrastive accenting consistently found an early facilitation of alternatives while studies with focus particles found either interference effects or no significant effects comparing across focus conditions.

This might suggest that the time-course and/or mechanisms that underlie the effects differ for contrastive accents and focus particles. However, except the second lexical decision study byByram-Washburn (2013), none of the experiments presented so far has directly compared focus particles and contrastive accents.[3] The aim of this chapter is to investigate the mechanisms underlying focus particles

[2]Byram-Washburn mentions those two possibilities in the conclusions section of her thesis (Byram-Washburn, 2013, p.128), but she does not take a stance on which possibility is more consistent with the data.

[3]Also, none of the studies with focus particles presented so far has tested an SOA of zero ms, but see the study by Gotzner & Spalek (submitted) presented in the next chapter.

and contrastive accent by directly comparing the two within a probe recognition paradigm. In this chapter, I focus on the recognition of mentioned alternatives across focus conditions. I further manipulate the timing between exposure to the stimuli and the recognition memory test.

6.2 Goals of Experiments 5 and 6

The aim of Experiments 5 and 6 is to investigate the cognitive mechanisms as well as the time-course of the activation of focus alternatives as a function of focus particles and contrastive pitch accents. All previous experiments presented in this dissertation (Experiments 1-4) compared a condition without a particle to conditions that contained either an exclusive particle or an additive particle while the focused element carried the same accent in all conditions. In all previous experiments of this dissertation the focused element carried an H*L accent (H* on accented syllable), in varying prominence. For example, the accent of the focused element in the dialog structures involving the correction (stimuli used in Experiments 1a, 2 and 3) was more prominent than in the other narrative items (stimuli used in Experiments 1b and 4).

In Experiments 5 and 6, we systematically compare bare H* accents with L+H* accents. We further combine exclusive and additive particles with an L+H* accent to see how focus particles and contrastive accents conjunctively affect the retrieval of alternatives. As was described in Chapter 2, several information-structural cues affect the perception of contrast. Following the proposal by Calhoun (2009), we assume that by choosing a particular structure, the speaker wishes to make the alternatives particularly salient for the hearer. Hence, it might be that highlighting the alternatives from multiple sources leads to additive effects. So, a sub question of Experiment 5 was whether combining focus alternatives with contrastive pitch accents increases the accessibility of contextual alternatives even further (compared with a bare contrastive accent).

In addition to the focus manipulation, we introduce a temporal delay manipulation in Experiment 5 that was based on Glenberg *et al.* (1987). Glenberg and colleagues investigated how the associatedness of a referent with a target object affected a participant's representation of the target object. Glenberg *et al.* (1987)

also included a manipulation of temporal delay in their experiments and found that the effects of associatedness were only significant when one filler sentence was presented before the recognition memory test. If no filler sentence was presented or two filler sentences were presented, no effects were observed. Therefore, the study suggests that foregrounding of a referent in a mental model requires time.

In Experiment 6, we extend the temporal delay between presentation and test by including a numeric distractor task. I will discuss how the quality of the delay affects the recognition of alternatives.

6.3 Experiment 5: Combining contrastive accents and focus particles

6.3.1 Rationale and predictions

Participants in Experiment 5 were presented with short discourses that mentioned two referents and one of them was mentioned again in the second critical sentence, either pronounced with (a) a non-contrastive accent (H*) or (b) a contrastive one (L+H*). In addition to the L+H* accent, condition (c) contained the exclusive particle *only* and (d) the inclusive particle *also*. After exposure to the stimuli, participants were asked to recognize the alternative to the noun mentioned in the critical sentences (not the mentioned noun in the critical sentence itself). Hence, we only test the retrieval of mentioned alternatives here.

For the experiments of this chapter, we used an item structure similar to Fraundorf *et al.* (2010) (see below). Fraundorf *et al.* (2010) did not find any differences across syntactic positions, that is whether the focus manipulation appeared in subject or object position. Here, we manipulate focus in subject position whereas we looked at focus in object position in the previous experiments. An advantage of testing subject alternatives was that the use of the particles (especially additive ones) was more natural than in the items used in the previous experiments of this thesis. A rating study presented later in this chapter confirms this intuition. Technically, we are dealing here with contrastive topics that bear a focus.

The predictions for Experiment 5 are as follows: the L+H* accent should facilitate recognition of the alternative to the accented item compared to the H* accent based on all previous experiments. According to the study by Glenberg *et al.* (1987), we expect such a facilitatory effect to be present at a delay of one filler sentence in the probe recognition paradigm.

Concerning the comparison between the L+H* condition and the particle conditions there are two alternative predictions: (1) If contrastive accenting and focus particles have the same effect on the recognition of alternatives, both should facilitate or interfere with the recognition of alternatives relative to the condition with an H* accent at a given delay. This seems unlikely based on the previous results we have presented in Chapter 4. (2) Alternatively, it might be that pitch accents are used immediately to encode information about the alternatives (see for example Watson *et al.*, 2008) while such effects might take more time to unfold in the case of focus particles. One reason might be the stronger competition among members of the alternative set. According to this hypothesis, we expect the L+H* accent to facilitate the recognition of alternatives after one intervening filler sentence whereas the particles should cause an interference effect relative to the condition with the bare L+H* accent.

6.3.2 Methods

6.3.2.1 Participants

A total of 24 native speakers of German (15 female and 9 male, mean age 26.1 years, age range 22-30) were recruited from a participant pool at the Institute of Psychology of Humboldt University and were paid seven Euros in compensation. None of them reported any vision or hearing difficulties.

6.3.2.2 Materials

Stimuli We created 80 discourses that followed the structure of the example presented in (1). All experimental materials are shown in Appendix A.4. The first sentence introduced two referent nouns. The second critical sentence mentioned one of the referents again and described an action. As described above, we introduced a delay variable: On 50 percent of the trials, an additional filler

sentence (in brackets in the example) was presented. The filler sentence always consisted of five words and contained a pronoun (Glenberg *et al.*, 1987). The pronoun was ambiguous between the two referents, since the gender of the contrasting nouns was always the same. Across stimuli, the order of mention of the two referents was counterbalanced, that is, whether the first or second noun of the first sentence was mentioned again in the second sentence. An example is displayed in (1).

(1) **Context sentence:**
Der Richter und der Zeuge verfolgten die Beweisführung
'The judge and the witness followed the argument'
Critical sentence:
(a) Der [Richter]$_{\text{F}}$ glaubte dem Angeklagten (H*)
(b) Der [RICHTER]$_{\text{F}}$ glaubte dem Angeklagten (L+H*)
(c) Nur der [RICHTER]$_{\text{F}}$ glaubte dem Angeklagten (L+H*-*only*)
(d) Auch der [RICHTER]$_{\text{F}}$ glaubte dem Angeklagten (L+H*-*also*)
'(Only/also) the [JUDGE]$_{\text{F}}$/the [judge]$_{\text{F}}$ believed the defendant'
Filler Sentence:
(Er verkündete das Urteil)
('He announced the verdict.')

The critical sentences were recorded in four versions in each of the conditions (H*, L+H*, *only* and *also*) by myself. After recording, the utterance with the L+H* accent (b) was cross-spliced into the two utterances with *only* (c) and *also* (d). Thereby, conditions (b), (c) and (d) all contained the L+H* accent and all prosodic characteristics of the sentences were held constant. In total, there were eight experimental conditions: four focus conditions crossed with the delay of either zero or one filler sentence.

Acoustic measurements Acoustic analyses were performed to compare the accented syllable of the (a) H* and (b) L+H* conditions. Figure 6.1 shows the pitch contour of the accented syllable averaged over all items.

Additionally, statistical analyses were performed to compare the duration, maximum pitch, pitch difference and intensity across accent type conditions. Ta-

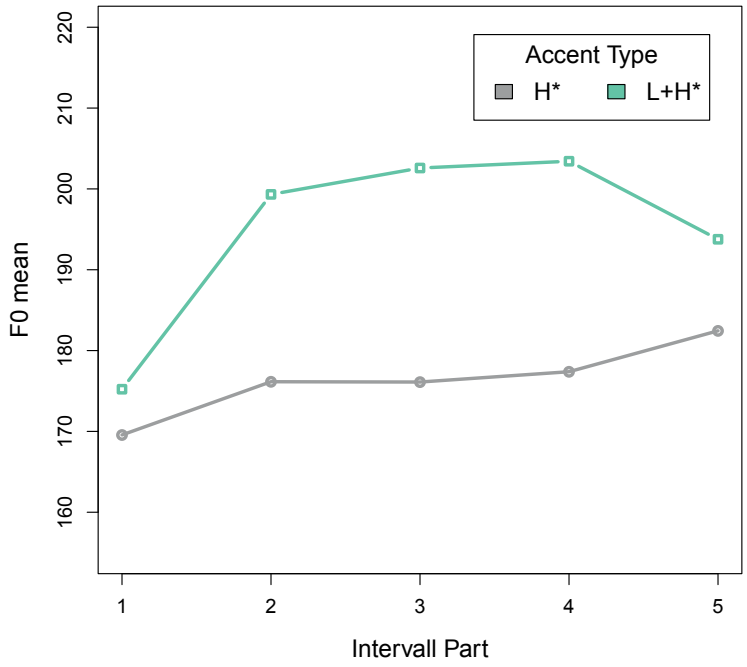

Figure 6.1: Mean pitch contour of the accented syllable of the focused element in Experiments 5 and 6

ble 6.1 summarizes the means, standard deviations and results of repeated measures ANOVAs (within item) comparing these acoustic parameters. The analyses confirmed that the syllable with L+H* accent had a higher pitch excursion, a greater pitch difference, intensity and duration.

Table 6.1: Mean acoustic parameters of the accented syllable of the focused element in the critical sentences (e.g., *Richter* in example (1)).

Parameter	H*	L+H*	$F_{(1,79)}$	p
Duration (s)	0.17 (0.01)	0.23 (0.01)	129.1	0.001
Maximum Pitch (Hz)	195.1 (4.5)	226.9 (6.2)	19.7	0.001
Pitch difference (Hz)	33.6 (4.5)	56.3 (6.2)	8.5	0.005
Intensity (dB)	69.1 (1.9)	73.3 (2.2)	208	0.001

We decided not to cross-splice the two accent types into one carrier sentence, since it has been argued in the theoretical literature that contrastive and non-contrastive accents might also differ in the postnuclear prosodic contour in that the former show a sudden drop in pitch contour while the latter are more sustained (e.g., Chafe, 1976). Such a difference was for example evident in the prosodic study by Krahmer & Swerts (2001). The fundamental frequency of the L+H* condition after the accented syllable tended to be lower than that of the H* accent in our stimuli but the pitch contour of the rest of the sentence was similar.

Counterbalancing Critical trials always probed recognition of the alternative to the noun in subject position, hence requiring a *yes*-response. A set of 50 filler items was constructed and 60 items from another experiment (Experiment 3 of this thesis) were added to counterbalance *yes*- and *no*-respwe wonses and to prevent subjects from concentrating on the nouns in subject position. Half of the filler items consisted of two sentences and half of them consisted of three sentences. Eight experimental lists were created by rotating through the focus (H*, L+H*, *only* and *also*) and delay conditions (zero vs. one filler sentence) according to a Latin square design. Hence, there were ten items per condition within a given list. Each list further contained the 110 filler items resulting in a

total of 190 items. The lists were pseudo-randomized for each participant so that no more than three filler or test trials were presented in a row and a given focus condition appeared only twice in a row.

6.3.2.3 Procedure

The experiment started with an instruction displayed on the computer screen. The instructions told the participants that they will be presented with auditory stimuli and that their task is to decide whether a word had appeared in the story or not. They were also asked to respond as accurately and as quickly as possible and to listen to the exact wording. After the instructions were displayed, participants performed four practice trials and were allowed to adjust the sound volume.

Each trial began with the onset of a central fixation cross displayed for 700 ms followed by a discourse that was presented over headphones. Each of the sound files included 2000 ms of silence after the last sentence. On 50 percent of the trials, the audio files contained an additional filler sentence. Probes appeared after the entire audio files, that is, they appeared either after the critical sentence (50%, delay zero) or after the filler sentence (50%, delay one).

Each probe was administered visually with an offset of 50 ms and the participants indicated whether it had appeared in the discourse by button press. The probe word stayed on the screen until a response was made. If subjects did not respond within a time frame of 4000 ms, the trial counted as a miss. With an offset of 500 ms the next trial was initiated. Every 33 trials, subjects had a short break. In total, there were six experimental blocks. The entire experiment lasted about 50 minutes.

6.3.3 Results

Trials in which subjects responded incorrectly (5.9 %) or that were more than two standard deviations from a participant's mean reaction time (4.9 %) were excluded from the analysis. Accuracy was similar across conditions. Since we had different predictions for the two delay conditions, we fit two separate models for the two data sets.

Figure 6.2 shows the mean RTs and standard errors across focus conditions at zero delay. The final statistical model contained the focus condition and trial as fixed factors, subjects, items as random factors and random slopes for trial. We chose the condition with the L+H* accent as reference level, since the two conditions with particles contained an L+H* accent as well and since we were interested in whether the particles caused effects in addition to the contrastive accent. Twenty-seven observations were excluded. Regarding the focus conditions, the model did not reveal any reliable difference across conditions ($p > .2$; see Table 6.2 concerning details of the model). This is in line with Glenberg *et al.* (1987) who argued that effects of foregrounding in a mental model should only be observable at a certain amount of delay.

Figure 6.3 displays the mean RTs broken down by focus condition at delay one. The final mixed effects model for this data set contained the same factors (27 observations excluded). The analysis revealed that the alternatives were recognized slower in the condition with H* accent in comparison with the L+H* accent ($t = 2.8$, $SE = .03$, $p < .01$). Hence, the L+H* accent facilitated recognition of the alternatives. Compared to the condition with L+H* accent, the two particles *only* and *also* led to slower probe recognition times (L+H* vs. *only*: $t = 2.0$, $SE = .03$, $p < .05$; L+H* vs. *also*: $t = 2.5$, $SE = .03$, $p < .05$). Thus, adding a focus particle to the contrastive pitch accent led to an interference effect. Table 6.3 summarizes estimates, confidence intervals and p-values extracted by Markov chain Monte Carlo sampling (10000 runs).

Table 6.2: Results of mixed effects model for delay zero in Experiment 5 (n = 803, log-likelihood = -206.1) including estimates, confidence intervals and p-values.

	Estimate	**Lower**	**Upper**	**pMCMC**
Intercept	6.47	6.37	6.56	0.0001
H*	0.04	-0.02	0.09	0.18
L+H*-*only*	0.002	-0.05	0.06	0.94
L+H*-*also*	0.01	-0.04	0.07	0.720
Trial	-0.01	-0.004	-0.002	0.0001

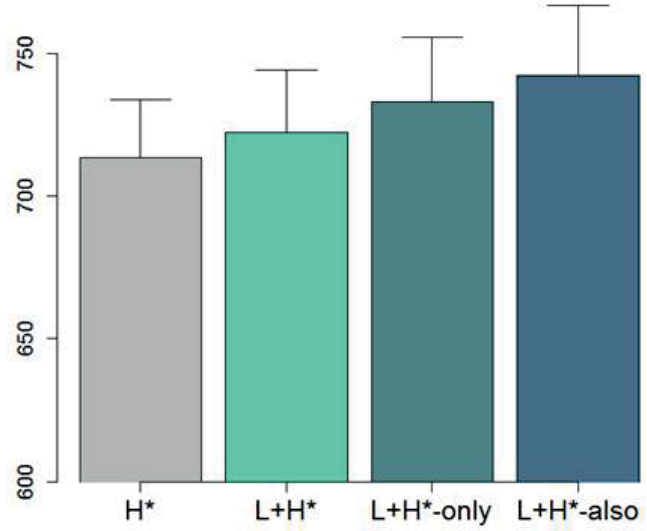

Figure 6.2: Mean RTs for mentioned alternatives at a delay of zero filler sentences (Exp. 5). Error bars represent standard error.

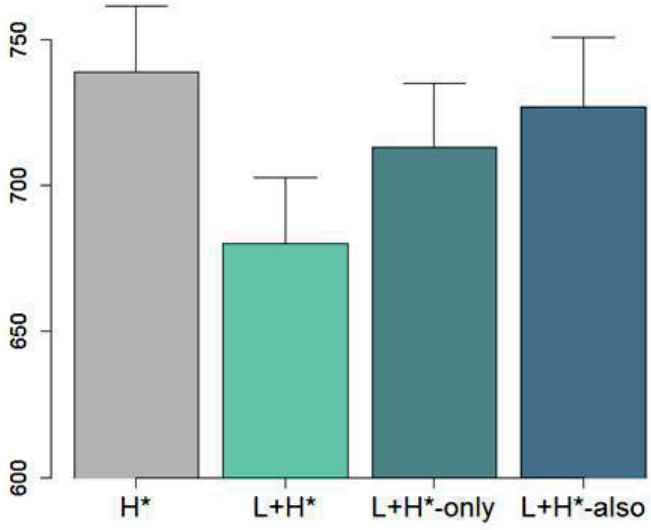

Figure 6.3: Mean RTs for mentioned alternatives at a delay of one filler sentence (Exp. 5). Error bars represent standard error.

Table 6.3: Results of the mixed effects model for delay one in Experiment 5 (n= 828, log-likelihood = -222.6) including estimates, confidence intervals and p-values.

	Estimate	**Lower**	**Upper**	**pMCMC**
Intercept	6.39	6.30	6.49	0.0001
H*	0.08	0.03	0.14	0.01
L+H*-*only*	0.060	0.00	0.11	0.05
L+H*-*also*	0.07	0.01	0.13	0.020
Trial	-0.01	-0.004	-0.002	0.0001

6.3.4 Discussion

Different accent types Experiment 5 extends earlier findings on the role of pitch accents in the retrieval of contextual alternatives in two ways. First, it indicates that the L+H* accent not only induces priming or activation of contrastive alternatives (Braun & Tagliapietra, 2010, Husband & Ferreira, 2016) but it also benefits probe recognition memory for contextual alternatives. Second, it shows that such effects already unfold after one intervening filler sentence (in comparison with the long delay introduced by Fraundorf *et al.*, 2010).

Our recognition memory task required participants to construct a mental model from the auditory discourses they were presented with and they had to recognize a referent that was an alternative to the element mentioned in the critical sentences. The stimuli used here provided a contextual set of alternatives with two elements. In accordance with Glenberg *et al.* (1987), the effects we observed only evolved after the inclusion of one filler sentence. I will discuss possible reasons for this in the general discussion of this chapter.

The recognition times for the H* and L+H* accent were equal at the delay of zero filler sentences. With the delay of one filler sentence, the two accent types caused differential effects. This pattern of results is in line with the lexical decision study by Husband & Ferreira (2016). They found that with an immediate SOA contrastive targets to a prime were facilitated if the prime words were pronounced neutrally or contrastively. At a longer SOA, the contrastive associates

only maintained facilitation in the condition with L+H* accent. Hence, it seems that initially the activation of contrastive alternatives does not differ across H* and L+H* conditions. Subsequently (at a delay of one filler sentence in our experiment), the activation of the alternatives decays in the H* case and augments in the L+H* case.

A previous study by Watson *et al.* (2008) suggests that the interpretational domains of the two accent types overlap to some extent in that H* accents are compatible with contrastive and non-contrastive referents whereas L+H* favor contrastive referents. The results of Experiment 5 are in line with this assumption: It is plausible that initially both accent types make contrastive alternatives available to the listeners, but this representation only seems to remain salient in the L+H* case. The data are therefore most compatible with the assumption that H* and L+H* accents do not necessarily form two discrete categories but that the latter is the more contrastive variant of the former.[4]

Focus particles The L+H* pitch accent made the mentioned alternative more accessible at a delay of one filler sentence. In contrast, adding either an exclusive or inclusive focus particle led to a processing cost. It is conceivable that the observed response pattern is due to a facilitatory effect by the contrastive accent combined with an interference effect of the particles, since the conditions with particles contained exactly the same (cross-spliced) recorded utterance.

Such interference effects are consistent with the results of Experiments 2, 3 and 4, where we found that participants were slower in recognizing or rejecting alternatives to a focused expression in case the utterances contained the particles *only*, *even* or *also* (vs. no particle). In Chapter 4, I have argued that the interference effects reflect competition mechanisms among the set of alternatives and that competition might be stronger in the case of focus particles compared to bare intonational focus. Experiment 5 again indicates that focal particles have an additional effect on the retrieval of alternatives, even in utterances with contrastive pitch accents.

[4]What is more, recent phonetic studies cast doubt on the distinction between H* and L+H* accents, suggesting that there is no special contrastive L+H* accent (see especially Kügler & Gollrad, 2015 as well as Repp, to appear for an overview).

Time-course At the beginning of this chapter, I have outlined two possibilities regarding the time-course of the activation and inhibition of alternatives: an initial facilitation vs. an initial inhibition hypothesis. The review of the previous experimental results already suggested some differences in the results of studies using contrastive accenting compared to focus particles. However, the methodological differences made it difficult to conclude anything definite from those previous studies. In Experiment 5, we compared focus particles and contrastive accents directly and found that L+H* accent facilitated the recognition of mentioned alternatives while focus particles led to a processing cost relative to the condition with the L+H* accent. This might indicate that the information provided by the two focus manipulations might be integrated at different points in time. For example, it might be the case that contrastive accents facilitate the retrieval of alternatives more immediately than focus particles due to the additional function of focus particles.

The data at hand suggest that pitch accents cause an early facilitation of the alternatives. This makes sense if we assume that the function of intonational focus is to introduce or help identify alternatives. Focus particles have an additional function in that they associate with the element bearing intonational focus and establish a strong relation between the focused elements and its alternatives. Due to stronger competition among elements of the alternative set we might observe additional interference effects of focus particles.

Yet because we did not observe any interference effects of pitch accents (or facilitatory effects by focus particles compared with the other focus conditions), this does not exclude the possibility that they emerge at some point. Before continuing this discussion in greater detail, I will present the results of Experiment 6, which introduced a longer delay with a distractor task to see how the effects of the two focus manipulations unfold under such conditions.

6.4 Experiment 6: Longer delay with distractor task

6.4.1 Goals and predictions

Experiment 6 further investigates the effects of pitch accents and focus particles in a probe recognition paradigm. As was outlined above, Glenberg *et al.* (1987) found effects of foregrounding in a mental model when one filler sentence was presented before the recognition memory test but not in case zero or two filler sentences were presented. We, therefore, do not expect that extending the delay by a second filler sentence would allow us to investigate the salience of alternatives at later time windows. Instead we chose to include a numeric distractor task to extend the time between exposure and test.

Participants in Experiment 6 were exposed to the same items as in Experiment 5 in the version that did not include a filler sentence.[5] Before the probe word appeared on the screen, participants had to solve simple mathematical operations. The distractor task we included in Experiment 6 was similar to the ones used in operation span tasks (e.g., Turner & Engle, 1989; see Conway *et al.*, 2005 for a methodological review). Participants saw simple mathematical equations and had to indicate whether the result of the equation was correct or incorrect. The additional task introduced a delay of up to 10.5 seconds between the presentation of a discourse and the initiation of the probe word (depending on how long participants took to solve the task, see the procedure section).

In addition to introducing a temporal delay, the distractor task tapped into participants' attentional or working memory resources. The idea of a distractor task is to engage executive attention processes to prevent participants from rehearsing the stimuli (Conway *et al.*, 2005). Performing an additional task before the recognition memory task might increase the difficulty of the probe recognition task. The activation or memory of the probes might therefore decay to a greater extent, possibly rendering the differences between focus conditions more observable (see Birch & Garnsey, 1995 for a similar reasoning).

[5]The items are similar to the discourses in Experiments 1a, 1b, 2 and 3 in that the last sentence was the critical sentence.

6.4.2 Methods

6.4.2.1 Participants

A total of 24 native speakers of German (15 female and nine male, mean age 25.5 years, age range 20-31) were recruited from a participant pool at the Institute of Psychology of Humboldt University and were paid eight Euros in compensation. None of them reported any vision or hearing difficulties.

6.4.2.2 Materials

Auditory stimuli In Experiment 6, we used 60 of the original stimuli from Experiment 5 as critical stimuli. Only the versions of the items with no additional filler sentence were used. Hence, the last sentence was always the critical sentence. The 60 experimental items were spread across 4 stimulus lists so that a given participant received 15 items in one condition. We always presented the subject alternative in the critical trials, totaling in 60 yes-responses.

The remaining 20 items from Experiment 5 were used as filler items presenting a word from various parts of the discourses that had not been mentioned. Another set of 40 filler items from Experiment 5 with a similar structure were used, presenting a probe that had not been mentioned. Thereby, *yes* and *no*-responses were counterbalanced.

Distractor task Before participants were presented with the probe words, they had to solve simple mathematical operations. They were presented with the result of an equation and had to indicate whether it was correct or not by button press. An example of a correct and incorrect equation is *6 + 2 - 7 = 1* and *3 - 1 + 8 = 11* respectively. The list of mathematical operations was constructed in a separate array and was kept constant across experimental trials and participants. The difficulty of the operations increased throughout the experiment.

6.4.2.3 Procedure

An on-screen instruction explained the structure of the experiment. The instructions told the participants that they will be presented with auditory stimuli and

that their task is to decide whether a word had appeared in the story or not. They were told that before responding to the word, they had to solve a mathematical operation. Participants performed four practice trials and were allowed to adjust the sound volume.

Figure 6.4 exemplifies the sequence of one trial. Each trial began with the onset of a central fixation cross displayed for 700 ms followed by a discourse that was presented over headphones. The sound files included 2000 ms of silence after the last sentence which was always the critical sentence in this experiment. 1000 ms later, a mathematical operation string was presented on the computer screen. Participants could respond to the string within a pre-set time window of 6000 ms.

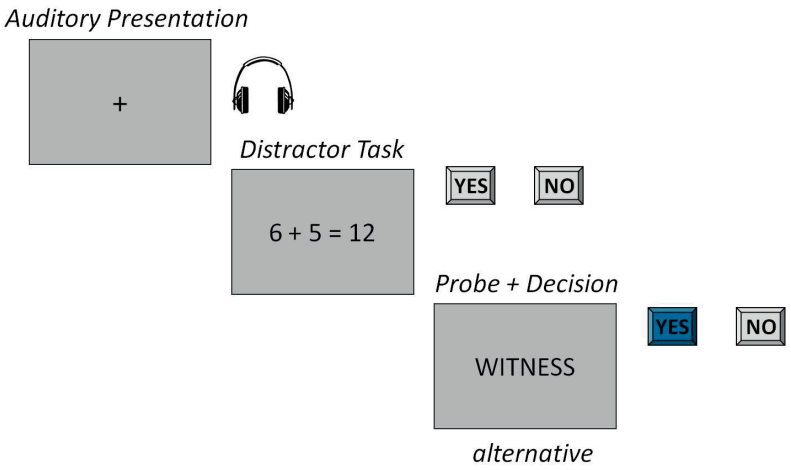

Figure 6.4: Trial sequence: Probe recognition with distractor task

With an offset of another 1000 ms a fixation cross appeared on the screen for 500 ms, immediately followed by the probe word. The probe was colored in green so that participants could easily keep track of the two different tasks. The probe word stayed on the screen until a response was made. If subjects did not respond within a time frame of 4000 ms, the trial counted as a miss. With an offset of 500 ms the next trial was initiated.

Every 20 trials, subjects had a short break. In total, there were six experimental blocks. The experiment lasted about 30 minutes. It was carried out in

conjunction with a separate experiment (which is not relevant for this thesis) in blocked presentation. The first half of the participants took Experiment 6 first and the other half completed the other experiment first. The entire test session took about 65 minutes.

6.4.3 Results

Table 6.4 shows the mean accuracy and reaction times for the recognition task as well as the reaction times for the distractor task across conditions.

Since the difficulty of the recognition task was increased by the distractor task in this experiment, we first analyzed the accuracy data across conditions. The final model contained the accuracies coded binomially, the focus conditions and trial as fixed factor and random effects for items and participants. None of the differences between conditions were significant (all p-values >.17). Table 6.5 summarizes the results of the model.

Table 6.4: Experiment 6: Mean accuracy rates and mean RTs for distractor task.

Measure/Condition	**Accuracy**	**RT distractor**
H*	0.93	2656
L+H*	0.94	2652
L+H*-*only*	0.96	2574
L+H*-*also*	0.94	2569

Incorrect responses were excluded from all further analyses. This resulted in a data loss of 3.8 %. We further excluded all data with reaction times that were more than two standard deviations from a participant's mean in a given focus condition. By this criterion, 3.4 % of the correct responses were excluded. Figure 6.5 shows the recognition times across conditions after outlier exclusion.

To analyze the differences across focus conditions, we fit a model with the reaction time data. The model with the best fit contained the log-RTs as dependent measure, focus and trial as fixed effects and random effects for subjects and items. In this experiment, we chose the H* condition as the baseline for

Table 6.5: Results of mixed effects model for accuracy rates in Experiment 6 (n = 1440, log-likelihood = 308.5) including estimates, confidence intervals and p-values.

	Estimate	**SE**	**z**	**p**
(Intercept)	2.56	0.32	7.98	0.00
H*	-0.10	0.32	-0.31	0.75
L+H*-*only*	0.56	0.41	1.37	0.17
L+H*-*also*	0.00	0.31	0.01	1.00
Trial	0.01	0.00	2.19	0.03

the initial model and evaluated the difference between the L+H* accent and the particle conditions in a post hoc test. Details of the model are displayed in Table 6.6.

The model revealed that the condition with *only* differed marginally from the baseline H* accent (p = .08). This difference was significant in the same model with non-transformed RTs (p = .018). The condition with L+H* accent and *also* were also numerically slower than the H* accent but this difference was not statistically reliable. A post hoc test showed that the conditions with bare L+H* also did not differ from the two conditions with particles.

Table 6.6: Results of mixed effects model for the recognition task in Experiment 6 (n=1285, log-likelihood =-501.9) including estimates, confidence intervals and p-values.

	Estimate	**Lower**	**Upper**	**pMCMC**
Intercept	6.96	6.87	7.05	0.0001
L+H*	0.02	0.03	0.07	0.4
L+H*-*only*	0.05	-0.008	0.1	0.08
L+H*-*also*	0.01	-0.04	0.06	0.6
Trial	-0.003	-0.003	-0.002	0.0001

We also fit a model for the reaction time data of the distractor task to evaluate

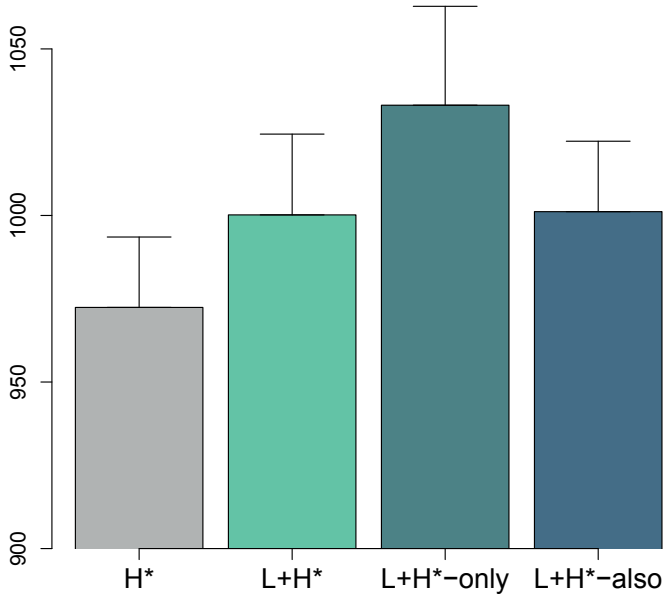

Figure 6.5: Mean RTs for mentioned alternatives (Exp. 6). Error bars represent standard error.

how long participants spend on this task. The model revealed that there were no significant differences in the time spent for the distractor task across focus conditions (all p's >.2). On average, participants spent 2.5 seconds on this task.

6.4.4 Discussion

In Experiment 6, the condition with the H* accent was numerically faster than all other conditions. The particle *only* caused a significant interference effect relative to the condition with H* accent. Note, however, that this difference was only marginal in the model with log-RTs. The conditions with *also* and the bare L+H* accent were numerically slower than the H* accent but these differences were not significant. It is interesting to note that the facilitatory effect of the L+H* accent vanished in this experiment whereas the particle *only* caused an

interference effect relative to the condition with H* accent. Hence, it seems that the additional distractor task affected the recognition of alternatives differently than did the additional filler sentence used in Experiment 5. The present results should, however, be taken cautiously since most comparisons were not significant.

In Experiment 6, the temporal delay between presentation and test was longer and additionally the numeric distractor task tapped into participants' working memory resources. The distractor task likely "distorted" participants' memory for the discourse to some extent or at least increased the difficulty of the probe recognition task. An experiment by Marty & Chemla (2013) manipulated the difficulty of a concurrent working memory task when participants were asked to judge the inferences of a given sentence. Interestingly, they found that when participants had to perform a difficult as opposed to an easy working memory task, they calculated less exhaustive implicatures in sentences with the quantifier *some*. In contrast, inference calculation was not affected by the difficulty of the working memory task in a condition with *only* (*only some*). These results suggest that the computation of non-truth conditional meaning of an utterance (the implicature of *some*) is more dependent on working memory resources than that of lexical truth-conditional meaning (the assertion of *only some*).

The study by Marty & Chemla (2013) might provide an explanation why the facilitatory effect of contrastive accents was not present in Experiment 6. However, it should be kept in mind that, in the present study, we looked at the retrieval of alternatives rather than the computation of inferences about those alternatives.

To summarize, Experiment 6 showed that the particle *only* caused an interference effect relative to the condition with H* accent. The reaction times in the conditions with the L+H* accent and *also* increased numerically but were not reliably different from the condition with the H* accent.

6.5 General discussion

In the following, I will compare the results of Experiment 5 and 6 and discuss possible aspects which might have contributed to the observed differences across experiments.

In Experiment 5, the delay between presentation and test was extended by an additional filler sentence, which continued the narrative. The additional filler sentence helped enriching a participant's mental model. Under these conditions, the alternatives were foregrounded by the L+H* accent (in line with Glenberg *et al.*, 1987). Glenberg *et al.* (1987) argued that upon mention a referent is likely to be foregrounded in a mental model independent of other factors. Therefore, they expected to see the effect of their manipulation (of the associatedness of a referent with a target object) only with a certain amount of delay. In our case, it is likely that at the offset of the critical sentence, the activation of the focused element was very high (for example in line with the study by Gernsbacher & Jescheniak, 1995). For this reason, we might have observed the effects of focus (and focus particles) on the retrieval of alternatives only after the additional filler sentence was presented. Another aspect might be that the filler sentence contained a pronoun which possibly led to the retrieval of a referent (which was also the case in Glenberg *et al.*, 1987).

Experiment 6, on the other hand, did not contain the additional filler sentence but instead used a working memory task, which as the name indicates distracted participants from the recognition task. This is probably the most striking difference between Experiments 5 and 6 rather than the extended temporal delay. In Experiment 6, the facilitatory effect of the L+H* accent was not present. Interestingly, though, there was an interference effect of the particle *only* relative to the condition with H* accent. It is hard to conclude anything from the condition with *also* since this condition differed from neither of the other conditions.

In any case, neither Experiment 5 nor Experiment 6 showed that the effects of contrastive pitch accents and focus particles were additive. To make a strong claim about the additivity of focus particles and contrastive accenting a design that fully crosses the two factors would be necessary. We did not employ a fully-crossed design here, because we had already compared the combination of focus particles with H* accents to a condition with bare H* accent in all previous experiments.

The comparison of L+H* accents and the combination of focus particles with an L+H* accent in Experiments 5 and 6 suggests that the effects of bare L+H* accents unfold differently than that of focus particles. It should be kept in mind

that the stimuli in Experiments 5 and 6 differed from the ones used in the experiments of previous chapters. First of all, the contrast set only consisted of two elements and second the focus manipulation appeared in subject position.

Still, we can say that independent of the item structure used, the more immediate studies consistently showed that contrastive pitch accents facilitated the recognition of alternatives. On the contrary, we found interference effects of focus particles (comparing across focus conditions) but never any facilitatory effects when a probe recognition task was performed directly after exposure to an item. In Chapter 7, I provide an overview of all experimental findings and continue the discussion of the comparison between pitch accents and focus particles.

6.6 Rating Study 2: Interaction of accent types and particles

Again to make sure that the observed effects were not due to general processing differences because of differences in the sentences' acceptability, a rating study was carried out. I have noted in Section 6.3.1 that our intuition was that the acceptability of the sentences with *also* and *only* were comparable in the item structure used for Experiment 5 and 6. A concern might be, however, that *also* could be less compatible with a contrastive accent, since contrastive accents signal the exclusion of alternatives while the particle *also* presupposes its truth. So, the first goal of rating study 2 is to measure the appropriateness of our stimuli.

Secondly, in order to investigate how focus particles interact with pitch accenting, it is important to find out what accent type focus particles most naturally combine with.[6] Two previous studies provide some insights into this question. Sudhoff (2010) conducted a series of production and perception experiments to investigate whether focus particles induce contrastive focus or rather interact with a given focus background structure. In the production study, four native German participants were asked to produce sentences with different focus background structures. In the perception study, another set of 40 participants was required to judge whether the utterances implied a contrast or not. The results

[6] I thank Duane Watson for helpful discussion concerning this point.

showed that focus particles were produced with both variants, either contrastive or non-contrastive pitch accents (independent of whether *only*, *even* or *also* was used). The perception study revealed that the contrast judgments were based on the given focus background structure, independent of whether a focus particle was used and which specific one was used. Therefore, Sudhoff (2010) suggested that the phonetic realization of the focused element is dependent on the focus background structure of the linguistic context and not on the presence or absence of a focus particle.

Dimitrova (2012) used the ERP technique to investigate how sentences with the Dutch particle *alleen* ('only') are processed in contexts with and without contrastive accenting. She found a positive ERP component around 200-500 ms for contrastive accents compared to utterances without an accent, which she refers to as an accent positivity. The particle *only* modulated the processing of accented constituents (compared with sentences without *only*): The accent positivity was delayed in sentences with *only* and additional early anterior negativities and late left anterior positivities were triggered. According to Dimitrova, the results suggest that sentences with *only* trigger additional processing costs, reflecting the expectation of an accent or the fact that *only* may require a contrastive accent. To summarize, it is currently unclear whether focus particles require a contrastive accent or are equally felicitous with contrastive and non-contrastive accents.

Here, we address the question what accent types focus particles most naturally combine with by using acceptability ratings. So, we test whether listeners perceive the combination of *only* and *also* with either a contrastive or a non-contrastive accent as more natural. Participants were presented with the stimuli we used in Experiments 5 and 6.

To investigate the interaction of focus particles with pitch accenting, we created a factorial design that fully crossed the factors focus particle (*only*, *also* vs. no particle) and pitch accent type (H* vs. L+H*). Ratings were performed in blocks of five items. A rating block of five items was followed by a second task which is not part of this dissertation.[7]

[7]In the second task participants judged statements about the discourses assessing whether they interpreted the discourses exhaustively (see Gotzner & Spalek, 2014).

6.6.1 Methods

6.6.1.1 Participants

A total of 24 native speakers of German (18 female and six male, mean age 25.25 years, age range 20-31) were recruited from a participant pool at the Institute of Psychology of Humboldt University. In total, 25 participants had participated in the study, but one of the subjects was bilingual (English as first native language) and was therefore excluded from further analyses. Participants were paid seven Euros. None of them reported any vision or hearing difficulties.

6.6.1.2 Materials

In this experiment, we only used the items with the additional filler sentence. We saw the differential effects of focus particles and pitch accents in Experiment 5 for exactly those items and the effects for the discourses without the additional filler sentences were less clear (in Experiments 5 and 6). Further, we did not want to make the experiment too long. Therefore, we decided not to use both versions of the stimuli.

We used the four original conditions and created two further conditions by cross-splicing either focus particle to the sentences with the H* accent (same method as the conditions with the particles combined with the L+H* accents were created). Hence, this experiment fully-crossed the factors particle and accent type totaling in the six conditions summarized in Table 6.7.

Table 6.7: Conditions in Rating Study 2.

Accent/Particle	***Only***	***Also***	**No particle**
H*	H*-*only*	H*-*also*	H* (bare)
L+H*	L+H*-*only*	L+H*-*also*	L+H* (bare)

The 80 experimental items of Experiment 5 and 6 had been spread across four conditions. In the rating study, we however used six conditions. Therefore, the items were spread across six experimental lists totaling in 13-14 observations per

condition.[8] Another set of 40 filler items with mild pragmatic violations was created so that participants rated acceptable and less acceptable items. An example of a filler item is shown in (2). All 40 unacceptable fillers were pronounced with a neutral intonational contour.

(2) Marie und Josi waren im Pferdestall
'Marie and Josi were in the horse barn'
Marie wollte die Pferde striegeln
'Marie wanted to groom the horses'
Sie bereitete immer das Essen vor
'She always prepared the food'

Six experimental lists were created, rotating through the accent and particle conditions. To each list, the 40 unacceptable filler items were added totaling in 120 items per list. Each participant received a different randomization with at most two filler items appearing in a row and the different experimental conditions being repeated at most twice. In one experimental block consisting of five trials, a specific topic/category only appeared once. In total, there were 24 short blocks.

6.6.1.3 Procedure

An on-screen instruction explained the structure of the experiment. The instructions told the participants that they will have to rate the naturalness of auditory stimuli and to remember the content of the stories. They were told to rate how coherent and natural the stories were on a scale from 1 (not at all acceptable) to 7 (very acceptable). We further asked them to indicate whether a statement was true or false regarding the content of a particular story (truth value judgment phase). We told participants that the statements could be implicit in the story. Five practice trials were administered before the experiment started.

The experiment consisted of two paired phases: (a) rating phases and (b) truth value judgment phases. Rating and truth value judgment phases interchanged

[8]Since 80 is not dividable by six, four conditions were presented 13 times and two of the conditions were presented 14 times within a given list.

every five items. After a total of five rating trials, a screen informed participants that the judgment phase would start and they had to judge the given statements as true or false.

Each experimental trial began with a central fixation cross displayed for 500 ms. Then, participants heard an item over headphones. Subsequently, they saw another fixation cross for 500 ms immediately followed by a scale from 1 to 7. Participants had to use a left and right button to browse through the array of numbers. By pressing a third button, they confirmed the selected number. Participants had a time window of up to 8000 ms for the rating. One presentation block lasted about 1.5 minutes.

In the truth value judgment phase, a fixation cross was displayed for 500 ms and then a blank screen was shown for 100 ms, immediately followed by the statement. A time window of up to 10000 ms was allowed for the judgment The statement was colored green so that participants could easily identify the judgment phase. The sequence of statements corresponded to the order of presentation of the auditory stimuli. After five judgment trials, a screen announced the start of the next presentation/rating block.

6.6.2 Results

We only describe the results of the rating phase here. Table 6.8 shows the mean ratings across particle conditions in the two different accent type versions H* and L+H*. The average rating of the incoherent filler items was 2.5.

Table 6.8: Mean appropriateness ratings in Rating Study 2.

Accent/Particle	***Only***	***Also***	**No particle**
H*	5.6	5.7	5.8
L+H*	5.9	5.7	5.9

We computed a mixed model with the ratings including the factor particle, accent type, an interaction of the factors and random effects for subjects and

Table 6.9: Results of mixed effects model for appropriateness ratings in Rating Study 2 (n = 1920, log-likelihood = -3256) including estimates, confidence intervals and p-values.

	Estimate	**Lower**	**Upper**	**pMCMC**
Intercept	5.84	5.50	6.24	0.00
L+H* (bare)	0.07	-0.34	0.46	0.75
L+H*-*Only*	-0.20	-0.58	0.20	0.35
L+H*-*Also*	-0.10	-0.52	0.27	0.64
L+H*-*Only*:H*	0.18	-0.36	0.76	0.55
L+H*-*Also*:H*	-0.09	-0.64	0.47	0.77

items. The model did not reveal any significant differences across conditions (all p's >.35). Results are summarized in Table 6.9. [9]

6.6.3 Conclusions

Rating study 2 revealed that the stimuli used in Experiments 5 and 6 were equally felicitous in conditions without a particle and with the addition of either an exclusive or additive particle. Moreover, the use of a particular particle was perceived as equally natural with an H* pitch accent and an L+H* accent on the focused element (and the different bare accent types were also rated the same).

Numerically, the condition with *only* was slightly more acceptable combined with the L+H* accent (5.9 vs. 5.6). This difference might point into the direction of the results by Dimitrova (2012) who showed some evidence that the particle *only* might require a contrastive accent. However, since there was no significant interaction, we conclude that focus particles are equally natural with either realization of the pitch accent on the focused element. This is in line with the study by Sudhoff (2010) and it confirms that the effects observed in Experiments

[9]The reaction time data were not analyzed because participants did not use a single button for each number but rather browsed through the array of numbers with a cursor. Therefore, the reaction time data have little meaning because they are confounded with the position of a number within an array.

5 and 6 were not due to naturalness differences across conditions or the fact that additive or exclusive particles less likely combine with a contrastive accent.[10]

It could be the case that participants were more tolerant to deviations in accentuation patterns due to the mild pragmatic violations in the filler sentences. However, because we were specifically interested in whether the different accentuation patterns were perceived as coherent, the filler sentences constituted the right kind of control. The average ratings of the experimental conditions ranged from 5.6 to 5.9. Since we used a rating scale from 1 to 7, the effects do not seem to be at ceiling. However, we cannot exclude the possibility that the pragmatic violations in the filler sentences made participants more tolerant for prosodic deviations.

Another objection might be that the lack of acceptability differences might indicate that participants did not perceive the difference between our intended accent conditions. Such an objection is ruled out by data from the truth value judgment task (not presented in detail here): Participants computed more exhaustive inferences in the condition with L+H* compared to H* indicating that the former was perceived as more contrastive than the latter (see Gotzner & Spalek, 2014 for details).

To conclude, Rating study 2 revealed that focus particles are perceived as equally natural with an H* accent or an L+H* accent and the contexts used in Experiments 5 and 6 were equally compatible with either focus condition.

6.7 Chapter summary

Experiments 5 and 6 combined focus particles with a contrastive pitch accent and compared the recognition of mentioned alternatives across different delays. In Experiment 5, we found that bare contrastive accents facilitated the recognition of mentioned alternatives compared with non-contrastive accents at an intermediate delay (with one additional filler sentence). Adding a focus particle to a contrastive

[10]It might be argued that we did not observe any differences across conditions because those were overshadowed by the additional filler sentence. Note, however, that the filler sentence was the same in all conditions. Therefore, it affected ratings equally in all conditions.

accent caused interference effects relative to the condition with a bare contrastive accent.

In Experiment 6, the delay was extended by a distractor task. In this experiment, the H* accent was numerically faster than all other conditions. The positive effect of the L+H* accent vanished and only the condition with *only* caused an interference effect relative to the condition with H* accent.

In Experiments 1a, 1b, 2 and 3 presented in the previous chapters, we combined focus particles with an H* accent in varying prominence. In Experiments 5 and 6, we combined them with a contrastive accent and observed that focus particles caused effects beyond the effects of contrastive accenting. The experiments further indicated that the time-course of the relative activation or inhibition of focus alternatives differs for contrastive accenting and focus particles. Overall, the two recognition memory studies suggest that contrastive pitch accents facilitate the recognition of mentioned alternatives, that is, such accents help identifying the relevant alternatives. Focus particles, on the other hand, cause additional interference effects indicating stronger competition between the focused element and its alternatives.

The rating study presented in this chapter showed that all conditions were perceived as equally natural and that focus particles can combine with both contrastive and non-contrastive accents. In the conclusions, presented in the next chapter, all experimental results will be compared and the differences between focus particles and intonational focus will be further spelled out.

Chapter 7

Conclusions

In this last chapter, I provide a summary of all findings and discuss the current data in relation to previous studies. I will further describe the theoretical relevance of the findings and show possible applications of the experimental paradigms used here. Subsequently, I discuss the relevance of the findings for research on language processing. Finally, I provide some general conclusions from the research presented here.

7.1 Summary of findings

This thesis looked at the semantics of bare intonational focus and that of focus particles. A series of seven experiments investigated the impact of the two on the representation of focus alternatives.

I started out by exploring later representations of the whole alternative set. Two delayed recall experiments (Exp. 1a and 1b) revealed that participants were better at recalling mentioned alternatives to a focused element when the discourse contained the particles *only* or *even*. This effect was replicated with narrative discourses indicating that the effects of focus particles generalize over different linguistic structures. In addition, the experiments showed that the focused element was remembered better than the alternatives.

Experiments 2 and 3 presented in Chapter 4 explored the cognitive mechanisms underlying the establishment of alternative sets. A probe recognition experiment found interference effects of focus particles in the recognition of mentioned

alternatives and the rejection of unmentioned alternatives. A lexical decision study with the same items revealed that mentioned and unmentioned alternatives were activated (compared with an unrelated condition) and that mentioned alternatives received the highest amount of activation. Again, interference effects of focus particles relative to a condition with bare intonational focus were present. These results suggest that a cohort of semantic competitors is activated and that the competition among members of the alternative set is stronger in utterances with focus particles.

Chapter 5 closely looked at the composition of the alternative set, that is which elements are included in this set. An additional analysis of Experiment 3 indicated that unrelated items become activated if and only if they are possible replacements of the focused element. In fact such unrelated items were as activated as semantically-related unmentioned alternatives. Experiment 4 compared semantic associates of a focused expression that were possible replacements or not. The data showed that focus particles only interfered with the rejection of possible replacements. Overall, the studies provide evidence for a so-called permissive view assuming that the set of alternatives consists of various possible replacements of the focused element.

Chapter 6 investigated the role of the pitch accent type on the focused element. The recognition of mentioned alternatives was compared across conditions with bare focus accenting (H* or L+H*) and conditions that combined focus particles with an L+H* accent. Experiment 5 showed that contrastive accents facilitated the retrieval of alternatives while focus particles caused interference effects relative to the condition with L+H* accent. Experiment 6 used an additional distractor task and found that the particle *only* again caused an interference effect while the facilitatory effect of the L+H* accent vanished. Experiment 5 and 6 indicate contrastive pitch accents and focus particles have a different impact on the retrieval of alternatives. In particular, the results suggest that (i) focal accents introduce a set of alternatives and that (ii) focus particles cause stronger competition between the focused element and its alternatives. I conclude from this that the cognitive function of focus particles is to highlight the relation between the focused element and its alternatives.

7.2 Comparison of contrastive accents and focus particles

7.2.1 Review of previous and current data

The delayed recall experiments presented in this thesis indicated that focus particles lead to better memory for the alternative set. The study by Fraundorf *et al.* (2010) found a similar effect of contrastive accents on the recognition of mentioned alternatives. In Chapter 6, I outlined two hypotheses: (1) either focus alternatives are first facilitated and then inhibited (initial facilitation hypothesis) or (2) the alternatives are first inhibited and then facilitated (initial inhibition hypothesis).

Tables 7.1 and 7.2 show an overview of all data for contrastive accents and focus particles respectively. A "+" sign indicates a positive/facilitatory effect and a "–" sign an interference effect. As can bee seen from Table 7.1, studies manipulating contrastive accenting consistently found an early facilitation of the alternatives (Braun & Tagliapietra, 2010, Husband & Ferreira, 2016 and Norris *et al.*, 2006). At a later offset, Byram-Washburn (2013) observed an inhibition of the alternatives in a mouse tracking paradigm. A question, however, would be how the results of the mouse tracking study compare to other tasks.[1] In Experiment 5 of this dissertation, contrastive accents caused a facilitation of the alternatives at an intermediate offset and this effect vanished in Experiment 6, where the delay between presentation and test was extended through a numeric distractor task. There are methodological differences between the studies (task, choice of baseline, mention of the alternatives) and it is conceivable that, depending on the task, the time-course unfolds differently. Considering Table 7.1, still a quite clear picture emerges supporting the initial facilitation hypothesis for contrastive accents. I interpret these results as indicating that intonational focus either introduces alternatives into computation (especially when no alternatives are mentioned contextually) or helps identifying the relevant alternatives.

[1] For example, the mouse-tracking study by Byram-Washburn (2013) induced a competition between alternatives in the visual display.

Table 7.1: Meta summary of studies manipulating contrastive accenting (N (2006) = Norris *et al.*, 2006; B & T (2010) = Braun & Tagliapietra, 2010; H & F (2012) = Husband & Ferreira, 2016; B-W (2013) = Byram-Washburn, 2013)

Study	**Task**	**0**	**250**	**2000**	**5500**	**7000**
N (2006)	LDT	+				
B & T (2010)	LDT	+				
H & F (2012)	LDT	+				
B-W (2013)	LDT, self-paced		n.s.			
B-W (2013)	Mouse-tracking		**-**			
Exp.5	Probe Recognition			n.s.	+	
Exp.6	Probe Recognition					n.s.

Table 7.2: Meta summary of studies with focus particles (B-W (2013) = Byram-Washburn, 2013; S & G (prep.) = Gotzner & Spalek, submitted)

Study	**Task**	**0**	**250**	**2000**	**5500**	**7000**
B-W (2013)	LDT		n.s.			
B-W (2013)	LDT		**-**			
Exp.2	Probe Recognition			**-**.		
Exp.3	LDT			−/+		
Exp.4	Probe Recognition			**-**.		
Exp.5	Probe Recognition			n.s.	**-**	
Exp.6	Probe Recognition					**-**
S & G (prep.)	LDT	n.s.				

Looking at Table 7.2, it becomes obvious that most studies with focus particles found interference effects relative to a condition with bare intonational focus. Note that our lexical decision study 3 showed that the alternatives are activated (relative to an unrelated condition) but the specific contribution of focus particles was an interference effect. This effect was replicated in almost all experimental paradigms which used immediate or intermediate time points.

There is some additional evidence from a study by Gotzner & Spalek (submitted) who tested the retrieval of alternatives directly at the offset of the focused word. In this study, we used the items of Experiment 1a (also used in Experiments 2 and 3) within a lexical decision paradigm. The results revealed semantic priming effects in the condition without a particle. In the condition with *only*, on the other hand, no priming effects were found. Across focus conditions, the interference effects were not statistically significant. These results suggest that activation and competition mechanisms unfold more slowly in utterances with focus particles compared to intonational focus. Such a claim is also consistent with the study by Dimitrova (2012) who found evidence that focus particles lead to delayed ERP effects.

At first glance, these results seem to support the initial inhibition hypothesis, that is, most studies with more immediate test points observed a processing cost associated with focus particles. However, an important qualification is in place here. From the lexical decision studies, it can be seen that in sentences with focus particles alternatives become activated. This is most likely the contribution of intonational focus to a great extent. The specific effect of a focus particle is an interference effect which provides evidence for a processing cost associated with the establishment of alternative sets. I assume that competition mechanisms are stronger in the case of focus particles because of association of the focused element with the alternative set.

In sum, the initial facilitation vs. inhibition debate is too simplistic. Rather, it seems that intonational focus and focus particles affect the retrieval of alternatives conjunctively. The results suggest that focus accents introduce a set of alternatives or help narrowing down the relevant alternatives when a set of alternatives is introduced contextually. Focus particles cause additional interference effects reflecting a (stronger) competition among the alternatives. Therefore, it

seems that focus particles highlight the relationship between the focused element and its alternatives. This is also reflected in the delayed recall studies where the alternatives were recalled almost equally well as the focused element in the conditions with focus particles.

7.2.2 Elimination of alternatives and the role of mention

Why would we expect a contrastive accent to activate/facilitate contextual alternatives if our intuition is that contrastive accents "eliminate"/exclude alternatives in some sense? First of all, alternative semantics assumes that the function of focus is to introduce alternatives into derivation. Therefore, it is plausible that alternatives become activated. Second, in order to negate the alternatives it is likely that first the affirmative content needs to be represented. This argument runs parallel to what has been claimed for the processing of negation. Studies on negation suggest that the asserted part of a statement first becomes active before it is negated in the mental representation (e.g., Kaup & Zwaan, 2003).

Our findings are also consistent with work on homonym comprehension. For example, Swinney *et al.* (1979) showed that initially both the contextually appropriate and the inappropriate meaning of a homonym are activated to the same extent. Gernsbacher & Faust (1991) present a model of homonym comprehension involving initial activation of various meanings of a word and later suppression of contextually-inappropriate meanings. Strikingly, they found an activation of contextually-inappropriate meanings even when the context sentence had already created a strong bias toward the intended meaning. However, when testing the activation of the different meanings later (e.g., with an SOA of 700 ms), the inappropriate meaning was deactivated, not only returning to baseline but being suppressed.

However, one crucial difference between these studies and the studies on focus alternatives should be noted. The experiments presented here indicate that focus alternatives are not entirely suppressed. For example, Experiments 1a and 1b showed that the alternatives are remembered better in utterances with focus particles. Experiment 5 showed that at an intermediate offset (with one filler sentence) contrastive accents facilitate the retrieval of mentioned alternatives.

Further, the study by Fraundorf *et al.* (2010) showed that even one day later listeners can retrieve information about contextual alternatives. All these results show that focus and focus particles have (long-) lasting effects on the representation of a discourse, highlighting the relevance of alternatives. What is more, the results show that alternatives are not suppressed but remain salient in a listener's mind.

We found similar effects when a set of alternatives was mentioned in the context compared to a context in which the alternatives remained implicit (Experiment 4). This shows that similar mechanisms are at play with and without discourse mention of alternatives. Does this mean that mention does not affect the establishment of alternative sets? I believe such a conclusion would be false. For example, Kim (2012) showed that mentioned elements are more likely to be considered as alternatives. Note also that we did not test the long-term retrieval of unmentioned alternatives. It is likely the case that those alternatives decay over the course of time. Whether or not a set of alternative is mentioned contextually might also influence the time-course of activation and inhibition mechanisms[1].

7.3 Relevance of the present research

7.3.1 Formal alternatives and contextual restriction

The experiments presented in Chapters 4 and 5 suggested that listeners consider a large set of alternatives, consisting of various possible replacements of a focused element. This is in line with the permissive view of alternative sets proposed by Rooth (Rooth, 1985, 1992). Importantly, the findings do not question that there is contextual restriction. The question addressed was whether restriction applies *a priori* such that listeners only consider a limited set of alternatives (for example, a contextually-enumerated one). In Rooth' account the set of alternatives consists of various possible replacements and restriction applies at a global/pragmatic level. Other accounts like for example the one proposed by Wagner assume that the alternative set consists only of alternatives that satisfy the requirement of mutual exclusivity (e.g., Wagner, 2006; Wagner, 2012). According to such a

[1] I thank Jack Tomlinson for discussing this with me.

restrictive account, certain alternatives are excluded from consideration. As was outlined, the results presented here are most compatible with a permissive view of alternative sets.

Rooth presents a two-dimensional semantics of focus, where the focus semantic value is separate from the ordinary value. He further assumes that there is an additional level of representation, where contextual restriction applies. It seems that with the lexical decision and probe recognition tasks we tapped into the computation of the alternative set before it is narrowed down to the relevant members. Other experiments using for example the visual world paradigm found that listeners prefer mentioned alternatives and that other discourse factors restrict which elements listeners consider as alternatives early on (see especially the dissertation by Kim, 2012). Hence, the visual world paradigm appears to be more sensitive to the alternatives actually used in computation. This possibly follows from the fact that this paradigm presents a limited world and captures what is in the current focus of attention.

Are our results inconsistent with the findings of visual world studies? I do not think this is the case. On the contrary, I believe that the findings complement each other neatly. The studies by Kim (2012) looked at how listeners use alternatives to predict the upcoming focused element within a limited visual world while we looked more specifically at the representation of the alternatives. We were interested in whether there is a reflection of the computation of the formal/broader set of alternatives in processing. Our experiments showed that this is the case. More specifically, it seems that the computation of alternatives relies in part on general cognitive mechanisms such as activation and competitive inhibition.

Regarding the theoretical relevance of the findings, it seems that a distinction between a set of formal alternatives and the actual set used in computation is sensible cognitively (but see Fox & Katzir, 2011 for a discussion if this is desirable). Such a conclusion is supported by our experiments as well as the visual world studies by Kim (2012) and the studies by Byram-Washburn (2013). Overall, the data fit nicely with the alternative semantic proposal proposed by Rooth (1985, 1992) as compared with other proposals which need to stipulate alternatives as for example structured meanings (e.g., Krifka, 1992). The point is that structured meanings can but does not need to incorporate alternatives

whereas alternatives are crucial to focus in alternative semantics (see also Rooth, 1992' discussion concerning the hypothetical verb *tolf*.)

The paradigms we introduced here open up the possibility to investigate further important issues on how alternatives are composed. For example, a great deal of the literature on inferences (including for example scalar implicatures) is concerned with identifying the correct alternatives in order to derive the right inferences (and exclude the ones that do not arise). Our lexical decision paradigm seems to be sensitive to the formal/broader set of alternatives and there might be an opportunity to distinguish between a representation of the set of formal alternatives and the actual set used in computation. Let's take an example discussed by Krifka (1993) shown in (1).

(1) John only invited [Mary and Sue]$_{\mathrm{F}}$

Intuitively, sentence (1) does not give rise to the inference that John did not invite Mary or did not invite Sue. Instead it expresses that he invited Mary and Sue but nobody else. To predict the correct inference there are two options: The first option is to assume that the set of alternatives does not contain the individuals *Mary* and *Sue* so that none of the conjuncts is negated (e.g., *John did not invite Mary*). The second option, which Krifka (1993) adopts, is to modify the semantics of *only* such that *only* quantifies over elements that are ranked equally or higher on a scale (but not lower) than the focused element (see also Umbach, 2004 for a different proposal to account for this puzzle). In other words, Krifka maintains that the individuals Mary and Sue are part of the alternative set but assumes that *only* does not access/exclude these individual elements because they are ranked lower on the scale (assuming a partially-ordered set).

A prediction for our lexical decision paradigm would be that target words corresponding to the individuals (for example MARY) are primed by the conjunctive statement *John only invited Mary and Sue* in comparison with unrelated words, indicating that the individuals are part of the alternative set. To assess whether *only* accesses/excludes the individual conjuncts, one would compare the recognition of the individual words across a condition with *only* and without a particle. In this comparison, there should be no interference of the particle *only* relative to a condition without a focus particle, if we assume that the conjunction *Mary*

and Sue does not compete with the individual conjuncts (e.g., *Mary*). In other words, it might be the case that only alternatives of similar complexity compete with each other (see also the next section as well as Katzir, 2007 and Fox & Katzir, 2011). On the one hand, such experiments could help adjudicate between different theoretical proposals and answer important questions concerning the characterization of alternatives. On the other hand, theoretically-driven experiments might provide important novel insights into language processing. In the next section, I will describe a further area of research on which the current experiments bear relevance.

7.3.2 Alternatives in scalar implicature computation

Recent proposals in the literature on scalar implicatures have tried to unify focus alternatives and alternatives in scalar implicature computation. Rooth (1992) already noticed the relation between focus alternatives and scalar implicatures in that the placement of focus affects the implicatures available from an utterance. Traditionally, though, it is assumed that scalar implicatures are based on different kinds of alternatives, so-called "Horn" scales which depend on entailment relationships. The most prominent example of a Horn scale is the one of the quantifier *some* and the more informative quantifier *all*. Consider example (2).

(2) a. Some students passed the exam
b. All students passed the exam
c. Not all students passed the exam

The sentence (2)-(a) *Some students passed the exam* is assumed to compete with the more informative sentence (2)-(b) *All students passed the exam*. *Some* is semantically consistent with *all* (*Some and possibly all students passed the exam*) because *all* entails *some*. However, since there is a more informative alternative the speaker could have uttered, the hearer has reason to infer that (2)-(c) not all students passed the exam, that is, to assume that the more informative alternative (2)-(b) does not hold. The reasoning just described was based on lexical alternatives or Horn scales. It is assumed that items like *some* and *all* are encoded as scale mates in the mental lexicon. Furthermore, Hirschberg (1985)

observed that speakers can build *ad hoc* scales based on the context, where similar mechanisms apply.

Recently, Fox & Katzir (2011) have proposed a theory which unifies the alternatives of focus and scalar implicatures (see also Katzir, 2007). They assume that in both cases alternatives are computed by replacements from three different sources: the lexicon, the context and sub constituents of the utterance. The requirement is that the alternatives have a similar complexity in order to avoid what is known as the symmetry problem (see Matsumoto, 1995). This proposal shows that the current findings are relevant not only for theories on focus but also for theories of scalar implicatures.

Second, our findings show a potential source of the cost for implicature computation. Numerous studies have found a processing cost of implicature computation relative to the computation of semantic meaning (e.g., an early demonstration of the effect by Bott & Noveck, 2004; see also Chemla & Singh, in press for an overview). However, as Chemla & Singh (in press) have recently pointed out it is unclear what the source of this cost is, for example whether it genuinely reflects the derivation of the inference or rather the need to retrieve alternatives. The experiments reported here (in particular those of Chapter 4) show that access to alternatives has a processing cost due to competition among members of the alternative set. This processing cost might be another moderator of the differences observed in processing literal and pragmatic meaning.

7.3.3 Exclusive assertions vs. additive presuppositions

In Chapter 2, I have outlined that exclusive particles give rise to different inferences than additive particles. In our experiments, however, exclusives and additives patterned along – both types of particles benefited recall of mentioned alternatives and caused interference effects at more immediate test points. First of all, it should be noted that we did not test the inferences arising from sentences with focus particles but the activation of alternatives.

Second, it could be the case that the difference between additives and exclusives was not captured in our tasks[2]. For example, Kim (2012) found that *only*

[2]I am grateful to Christina Kim for raising this objection.

favored a subset of a previously introduced set whereas *also* triggered looks to a superset in a visual world paradigm. In our experiments, this difference could be seen in the comparison of mentioned and unmentioned alternatives. If we assume that *only* is restricted to a subset of the mentioned alternatives the particle should not show effects in the rejection/recognition of unmentioned items. Further, mentioned alternatives might be inhibited more strongly if *only* eliminates mentioned alternatives and selects the focused element. Most experiments of this dissertation however did not find any differences across particle conditions. How can we reconcile these differences across experimental paradigms? I assume that even when participants ultimately negate the alternatives in the case of *only*, the alternatives need to be under consideration at some point (similar to the claims made for homonym comprehension and negation, see above).

Further, we carried out an experiment using a similar truth value judgment paradigm like Fraundorf *et al.* (2010) with the items of Experiments 5 and 6 (Gotzner & Spalek, 2014). The experiment showed that listeners correctly infer the truth of the alternative with *also* and exclude the alternative with *only*. This confirms that listeners distinguish the meaning of the two particles. As I outlined, a similar exhaustive/exclusive inference arises with a contrastive accent (as with *only*). However, it is still plausible that listeners arrive at the inference via a different processing path. In any case, this dissertation looked at the activation of the entire alternative set and not the inferences drawn about the relevant alternatives. Ultimately, those two processes work hand in hand. However, with the experimental paradigms presented here we measured how activation spreading proceeds across mentioned and unmentioned alternatives.

A recent visual world study by Schwarz (2014) compared the exhaustive assertion triggered by *only* to the additive presupposition of *also*. The eye gaze patterns indicated that listeners evaluated presuppositions more immediately than asserted content. So, the additive presupposition of *also* might be integrated earlier into sentence meaning than is the exhaustive assertion associated with *only* (see also Kim, 2012 for work comparing *only* and *also* in online processing). Schwarz (2014) assumes this result to be most consistent with semantic theories that take presuppositions as a "pre-condition" on the common ground. Psycholinguistic experiments comparing additive and exclusive particles might

provide important insights into the distinctions of different types of meaning such as presuppositions, implicatures and assertions as well as theories of common ground.

7.3.4 The representation of the alternative set

The experiments presented in this thesis found evidence that the focused element gains a special representation among the set of salient alternatives. In addition, we found that a set of unmentioned alternatives is activated even when the context lists a set of elements. The Venn diagram displayed below sketches a partition of the alternative set ordered by subset relation. Our experiments indicate that the focused elements is relatively more salient than the mentioned alternatives and the mentioned alternatives relatively more salient/activated than the unmentioned alternatives (as evident in Lexical Decision Experiment 3).

The data presented in this thesis are in line with the permissive view of alternative sets proposed by Rooth (1992). The focused element corresponds to the ordinary semantic value, the mentioned alternatives to the contextual set of alternatives and the unmentioned alternatives to a part of the focus semantic value. The three levels form a subset relation and our experiments indicate that the salience increases along the continuum. In our analysis of unrelated items, we found evidence that the set of alternatives does not only contain taxonomic elements but that unrelated items can form part of the alternative set if they are possible replacements of the focused element, even when those unrelated items are not listed in the context.

7.3.5 Processing focal information

Previous research has concentrated on the processing and representation of focal information. This dissertation, in conjunction with other recent contributions (in particular, Fraundorf *et al.*, 2010; Braun & Tagliapietra, 2010; Kim, 2012; Byram-Washburn, 2013; Husband & Ferreira, 2016), suggests that focus not only alters the processing of focal information but adds alternatives into computation. Therefore, alternative sets appear to be an important cognitive unit.

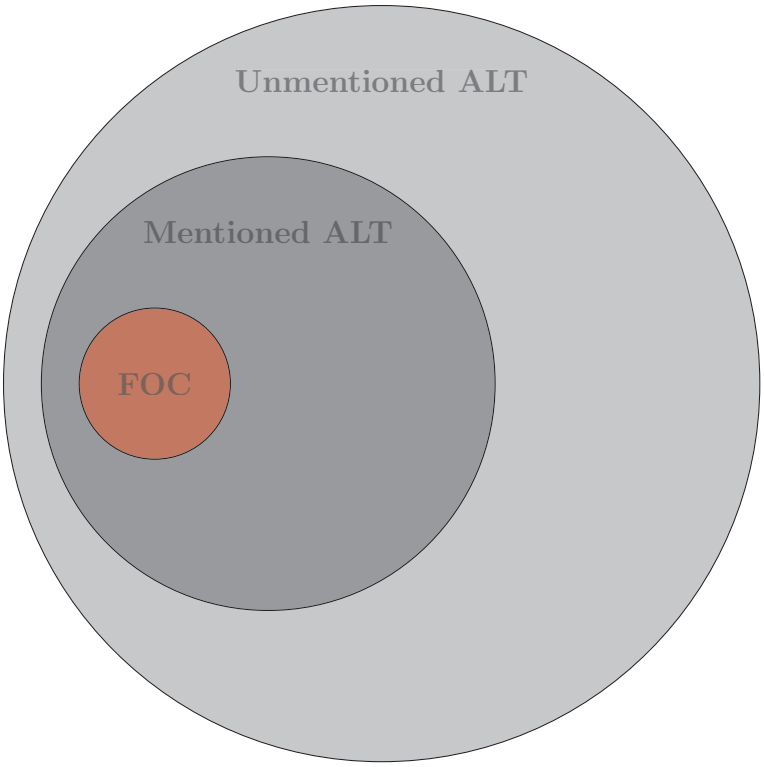

Figure 7.1: Representation of the alternative set

Previous studies on the impact of focus structure on sentence processing and memory storage have obtained differential, seemingly contradictory results – part of them showing facilitatory effects, part of them obtaining inhibitory effects for processing focused expressions (see for example (Birch & Rayner, 1995) and (Birch & Rayner, 2010) for a discussion). It is conceivable that some of the inhibitory effects observed in previous experiments were mitigated by the activation of alternatives to focused expressions. For example, Birch & Rayner (1995) found increased reading times when participants processed focused compared to non-focussed material. A reason for such longer reading time might be increased encoding costs due to the retrieval of alternatives (see also Drenhaus *et al.*, 2011). Such findings might be influenced by a number of factors, both contextual factors, the type of focus construction as well as other linguistic factors which influence the perception of contrastiveness as discussed in Section 2.1.5.

An important aspect for future research should be how the processing of focal information runs in parallel with the processing of alternatives, at which point in time alternatives are integrated into sentence meaning and whether the activation of alternatives interferes with the processing of focal information. The processing of alternatives might be relevant for a variety of domains where focus structure has been found to influence language processing, including anaphora resolution, parsing decisions and production choices.

7.4 Final conclusions

The experiments presented in this thesis provide evidence the alternative semantic account of focus developed by Rooth (1985, 1992) has psychological reality. In conjunction with other previous studies, we found that intonational focus evokes a set of alternatives in the listener's mind. Further, our experiments showed that focus particles lead to an increased competition among members of the alternative set (the focused element, mentioned alternatives as well as unmentioned alternatives) and facilitate later recall of mentioned alternatives. Therefore, I conclude that the establishment of alternative sets relies on two mechanisms: (1) The activation of a large cohort of possible replacements; and (2) the narrowing down

to the relevant alternatives by competitive inhibition (see also Husband & Ferreira (2016) for a similar conclusion). This dissertation shows that the focused element is selected from an alternative set, which is accessed during language comprehension. Hence, the processing of focal information is complemented by the processing of focus alternatives. To conclude, alternative sets constitute an important cognitive unit of representation.

Appendix A

Appendix A: List of experimental items

A.1 Items used in Experiments 1a, 2 and 3

1. Im Katalog sind Hemden, Hosen und Jacken. Ich wette, Matthias hat sich Hemden und Hosen gekauft. Nein, er hat sich _ / nur / sogar Jacken gekauft.

There are shirts, trousers, and jackets in the catalogue. I bet Matthias has bought shirts and trousers. No, he _ / only / even bought jackets.

2. In der Obstschüssel liegen Pfirsiche, Kirschen und Bananen. Ich wette, Carsten hat Kirschen und Bananen gegessen. Nein, er hat _ / nur / sogar Pfirsiche gegessen.

There are peaches, cherries, and bananas in the fruit bowl. I bet Carsten has eaten cherries and bananas. No, he _ / only / even ate peaches.

3. Im Getränkemarkt gibt es Wasser, Cola und Saft. Ich wette, Angelika hat Saft und Wasser gekauft. Nein, sie hat _ / nur / sogar Cola gekauft.

There is water, coke, and juice available at the drinks cash-and-carry. I bet Angelika has bought juice and water. No, she _ / only / even bought coke.

4. Im Zoo leben Zebras, Löwen und Affen. Ich wette, Peter hat Zebras und Löwen fotografiert. Nein, er hat _ / nur / sogar Affen fotografiert.

Zebras, lions, and monkeys live in the zoo. I bet Peter has taken pictures of zebras and lions. No, he _ / only / even took pictures of monkeys.

5. Im Baumarkt gibt es Pinsel, Sägen und Feilen. Ich wette, Jens hat Pinsel und Feilen nachbestellt. Nein, er hat _ / nur / sogar Sägen nachbestellt.

There are brushes, saws, and files at the hardware store. I bet Jens reordered brushes and files. No, he _ / only / even reordered saws.

6. Im Karton liegen Bleistifte, Lineale und Scheren. Ich wette, Sarah hat Lineale und Scheren weggeschmissen. Nein, sie hat _ / nur / sogar Bleistifte weggeschmissen.

There are pencils, rulers, and scissors in the box. I bet Sarah has thrown away rulers and scissors. No, she _ / only / even threw away pencils.

7. Im Musikzimmer stehen Geigen, Gitarren und Harfen. Ich wette, Anja hat Harfen und Geigen gestimmt. Nein, sie hat _ / nur / sogar Gitarren gestimmt.

There are violins, guitars, and harps in the music room. I bet Anja has tuned harps and violins. No, she _ / only / even tuned guitars.

8. In der Schatulle befinden sich Ketten, Ringe und Broschen. Ich wette, Karoline hat Ketten und Broschen angelegt. Nein, sie hat _ / nur / sogar Ringe angelegt.

There are necklaces, rings, and brooches in the casket. I bet Karoline has put on necklaces and brooches. No, she _ / only / even put on rings.

9. Im Geräteraum liegen Reifen, Matten und Seile. Ich wette, Martin hat Seile und Matten geholt. Nein, er hat _ / nur / sogar Reifen geholt.

There are hoops, mats, and ropes in the gym. I bet Martin has fetched ropes and mats. No, he _ / only / even fetched hoops.

10. Im Schuppen stehen Spaten, Besen und Harken. Ich wette, Doris hat Spaten und Besen gesäubert. Nein, sie hat _ / nur / sogar Harken gesäubert.

There are spades, brooms, and rakes in the shed. I bet Doris has cleaned spades and brooms. No, she _ / only / even cleaned rakes.

11. Im Waffenmuseum befinden sich Dolche, Pistolen und Speere. Ich wette, Stefan hat Dolche und Speere fotografiert. Nein, er hat _ / nur / sogar Pistolen fotografiert.

There are daggers, pistols, and spears in the arms museum. I bet Stefan has taken pictures of daggers and spears. No, he _ / only / even took pictures of pistols.

12. Im Kulturbeutel befinden sich Seife, Shampoo und Duschgel. Ich wette, Michael hat Shampoo und Duschgel benutzt. Nein, er hat _ / nur / sogar Seife benutzt.

There is soap, shampoo, and shower gel in the toilet bag. I bet Michael has used shampoo and shower gel. No, he _ / only / even used soap.

13. Im Möbelgeschäft gibt es Tische, Regale und Betten. Ich wette, Anna hat sich Betten und Tische angeschaut. Nein, sie hat sich _ / nur / sogar Regale angeschaut.

There are tables, shelves, and beds in the furniture shop. I bet Anna has looked at beds and tables. No, she _ / only / even looked at shelves.

14. Im Spälbecken sind Schässeln, Töpfe und Pfannen. Ich wette, Maria hat Töpfe und Schüsseln abgewaschen. Nein, sie hat _ / nur / sogar Pfannen abgewaschen.

There are bowls, pots, and pans in the sink. I bet Maria has washed pots and bowls. No, she _ / only / even washed pans.

15. Im Kinderzimmer befinden sich Murmeln, Kreisel und Bälle. Ich wette, Max hat mit Bällen und Kreiseln gespielt. Nein, er hat _ / nur / sogar mit Murmeln gespielt.

There are marbles, spinning tops, and balls in the nursery. I bet Max has played with balls and spinning tops. No, he _ / only / even played with marbles.

16. Im Kunstmuseum sind Statuen, Gemälde und Fotografien. Ich wette, Janine hat Fotografien und Statuen betrachtet. Nein, sie hat _ / nur / sogar Gemälde betrachtet.

There are statues, paintings, and photographs in the art museum. I bet Janine has looked at photographs and statues. No, she _ / only / even looked at paintings.

17. Im Elektrogeschäft gibt es Mikrowellen, Fritteusen und Toaster. Ich wette, Florian hat Mikrowellen und Fritteusen gekauft. Nein, er hat _ / nur / sogar Toaster gekauft.

There are microwaves, chip pans, and toasters in the electric shop. I bet Florian has bought microwaves and chip pans. No, he _ / only / even bought toasters.

18. Im Gemäseregal gibt es Paprikas, Gurken und Karotten. Ich wette, Katharina hat Karotten und Paprikas mitgenommen. Nein, sie hat _ / nur / sogar Gurken mitgenommen.

There are bell peppers, cucumbers, and carrots at the vegetables section. I bet Katharina has taken carrots and bell peppers. No, she _ / only / even took cucumbers.

19. Im Garten wachsen Erbsen, Bohnen und Zwiebeln. Ich wette, Felix hat Bohnen und Zwiebeln geerntet. Nein, er hat _ / nur / sogar Erbsen geerntet.

Peas, beans, and onions grow in the garden. I bet Felix has picked beans and onions. No, he _ / only / even picked peas.

20. In der Dose sind Bonbons, Kekse und Lutscher. Ich wette, Mark hat Lutscher und Bonbons gegessen. Nein, er hat _ / nur / sogar Kekse gegessen.

There are candies, cookies, and lollipops in the jar. I bet Mark has eaten lollipops and candies. No, he _ / only / even ate cookies.

21. Auf dem Blumenbeet wachsen Rosen, Nelken und Lilien. Ich wette, Susanne hat Rosen und Lilien gegossen. Nein, sie hat _ / nur / sogar Nelken gegossen.

Roses, carnations, and lilies grow on the bed. I bet Susanne has watered roses and lilies. No, she _ / only / even watered carnations.

22. Auf der Wiese sind Bienen, Fliegen und Mücken. Ich wette, Karl hat Mücken und Bienen gefangen. Nein, er hat _ / nur / sogar Fliegen gefangen.

There are bees, flies, and mosquitos on the meadow. I bet Karl has caught mosquitos and bees. No, he _ / only / even caught flies.

23. Auf der Einkaufsliste stehen Käse, Eier und Milch. Ich wette, Isabell hat Eier und Milch mitgebracht. Nein, sie hat _ / nur / sogar Käse mitgebracht.

There is cheese, eggs, and milk on the shopping list. I bet Isabell has brought eggs and milk. No, she _ / only / even brought cheese.

24. Auf dem Bauernhof leben Hähner, Ziegen und Kähe. Ich wette, Torsten hat Hühner und Kühe gefüttert. Nein, er hat _ / nur / sogar Ziegen gefättert.

Chicken, goats and cows live at the farm. I bet Torsten has fed chicken and cows. No, he _ / only / even fed goats.

25. Im Wald leben Fächse, Rehe und Igel. Ich wette, Lisa hat Füchse und Rehe gesehen. Nein, sie hat _ / nur / sogar Igel gesehen.

Foxes, deer, and hedgehogs live in the woods. I bet Lisa has seen foxes and deer. No, she _ / only / even saw hedgehogs.

26. Im Märchenbuch geht es um Hexen, Prinzen und Drachen. Ich wette, Simon hat von Prinzen und Drachen geträumt. Nein, er hat _ / nur / sogar von Hexen geträumt.

The storybook deals with witches, princes, and dragons. I bet Simon has dreamed of princes and dragons. No, he _ / only / even dreamed of witches.

27. Im Wäschekorb liegen Socken, Pullover und Kleider. Ich wette, Sebastian hat Kleider und Socken gewaschen. Nein, er hat _ / nur / sogar Pullover gewaschen.

There are socks, sweaters, and dresses in the laundry basket. I bet Sebastian has washed dresses and socks. No, he _ / only / even washed sweaters.

28. Im Schuhgeschäft gibt es Stiefel, Sandalen und Turnschuhe. Ich wette, Paula hat Stiefel und Sandalen gekauft. Nein, sie hat _ / nur / sogar Turnschuhe gekauft.

There are boots, sandals, and sneakers at the shoe shop. I bet Paula has bought boots and sandals. No, she _ / only / even bought sneakers.

29. In der Schublade befinden sich Taschen, Schals und Hüte. Ich wette, Julia hat Schals und Hüte herausgenommen. Nein, sie hat _ / nur / sogar Taschen herausgenommen.

There are bags, scarves, and hats in the drawer. I bet Julia has taken out scarves and hats. No, she _ / only / even took out bags.

30. Im Korb liegen Äpfel, Birnen und Pflaumen. Ich wette, Daniel hat Pflaumen und Äpfel herausgenommen. Nein, er hat _ / nur / sogar Birnen herausgenommen.

There are apples, pears, and plums in the basket. I bet Daniel has taken out plums and apples. No, he _only/even took out pears.

A.2 Items used in Experiment 1b

1. Mathias erhält ein Paket mit Jacken, Hosen und Hemden. Er überlegte sich, was ihm am besten gefiel. Er hat _ / nur / sogar die Hemden behalten.

Mathias receives a parcel with jackets, trousers and shirts. He wondered what suited him best. He _ / only / even kept the shirts.

2. Carsten greift in einen Korb mit Pfirsichen, Kirschen und Bananen. Er überlegte sich, auf was er Appetit hatte. Er hat _ / nur / sogar die Pfirsiche herausgeholt.

Carsten reaches for a basket full of peaches, cherries, and bananas. He wondered what he would like to eat. He _ / only / even took out the peaches.

3. Angelika holt aus dem Supermarkt Wasser, Cola und Saft. Sie wollte ihren Durst stillen. Sie hat_/ nur/sogar das Wasser kaltgestellt.

Angelika bought water, coke, and juice at the supermarket. She wanted to quench her thirst. She _ / only / even cooled the water.

4. Peter sieht im Zoo Zebras, Löwen und Affen. Er wollte sich später daran erinnern. Er hat_/ nur/sogar Affen fotografiert.

Peter watches zebras, lions, and monkeys in the zoo. He wanted to remember that. He _ / only / even took pictures of monkeys.

5. Jens zählt in seinem Baumarkt Pinsel, Sägen und Feilen. Er stellte fest, dass manches fehlt. Er hat _/ nur/sogar Sägen nachbestellt.

Jens counts brushes, saws and files in his hardware store. He noticed that some tools are missing. He _ / only / even reordered saws.

6. Sarah ordnet eine Umzugskiste mit Bleistiften, Linealen und Scheren. Sie überprüfte, was nicht mehr zu gebrauchen ist. Sie hat _ / nur / sogar die Bleistifte weggeschmissen.

Sarah arranges a packing case full of pencils, rulers, and scissors. She checked what she did not need anymore. She _ / only / even threw away the pencils.

7. Anja kommt in ein Musikzimmer mit Geigen, Gitarren und Harfen. Sie wollte ihren Musikunterricht vorbereiten. Sie hat _ / nur / sogar die Gitarren gestimmt.

Anja enters a music room with violins, guitars and harps. She wants to prepare her music lesson. She _ / only / even tuned the guitars.

8. Karoline betrachtet in ihrer Schatulle Ketten, Ringe und Broschen. Sie überlegte, was zu ihrem Outift passt. Sie hat _ / nur / sogar die Ringe herausgenommen.

Karoline looks at the necklaces, rings, and brooches in her casket. She wondered what she would go well with her outfit. She _ / only / even took out the rings.

9. Martin entdeckt im Geräteraum Reifen, Matten und Seile. Er äberlegte, welche Übungen er machen wollte. Er hat _ / nur / sogar Reifen herausgeholt.

Martin discovers hoops, mats, and ropes in the gym. He decided which exercises he would like to do. He _ / only / even got out hoops.

10. Doris sieht im Schuppen Spaten, Besen und Harken. Sie überlegte, was sie gebrauchen kann. Sie hat _ / nur / sogar Harken mitgenommen.

Doris detects spades, brooms, and rakes in the shed. She wondered what would need later on. She _ / only / even picked up rakes.

11. Stefan sieht im Waffenmuseum Dolche, Pistolen und Speere. Er war sehr interessiert. Er hat _/ nur/sogar Pistolen fotografiert.

Stefan discovers daggers, pistols, and spears in the arms museum. He was very fascinated. He _ / only / even took pictures of pistols.

12. Michael hat in seinem Kulturbeutel Seife, Shampoo und Duschgel. Er wollte sich waschen. Er hat _ / nur / sogar die Seife ausgepackt.

Michael has soap, shampoo, and shower gel in his toilet bag. He wanted to get clean. He _ / only / even took out the soap.

13. Anna betrachtet im Möbelgeschäft Tische, Regale und Betten. Sie äberlegte, was in ihre Wohnung passen könnte. Sie hat _ / nur / sogar Regale ausgesucht.

Anna looks at tables, shelves, and beds in the furniture shop. She considered what would look nice in her apartment. She _ / only / even chose shelves.

14. Maria findet im Spälbecken Schüsseln, Töpfe und Pfannen. Sie überlegte, was sie zum Kochen brauchte. Sie hat _ / nur / sogar die Pfannen abgewaschen.

Maria spots bowls, pots, and pans in the sink. She wondered what she would need for cooking. She _ / only / even washed the pans.

15. Max sucht in seinem Kinderzimmer nach Murmeln, Kreiseln und Bällen. Er konnte nicht alles finden. Er hat _ / nur / sogar die Murmeln verbummelt.

Max looks for marbles, spinning tops, and balls in his nursery. He wasn‘t able to find everything. He had _ / only / even lost the marbles.

16. Janine betrachtet in der Ausstellung Statuen, Gemälde und Fotografien. Sie sollte eine Rezension schreiben. Sie hat _ / nur / sogar die Gemälde erwähnt.

Janine looks at statues, paintings, and photographs at the exhibiton. She had to write a review. She _ / only / even mentioned the paintings.

17. Florian testet im Elektrogeschäft Mikrowellen, Friteusen und Toaster. Er äberlegte, was er noch gebrauchen kann. Er hat _ / nur / sogar Toaster gekauft.

Florian tries out microwaves, chip pans, and toasters in the electric shop. He wondered what he would need. He _ / only / even bought toasters.

18. Katharina steht vor einem Gemüseregal mit Paprikas, Gurken und Karotten. Sie überlegte, was sie noch zu Hause hat. Sie hat _ / nur / sogar Gurken mitgenommen.

Katharina looks at bell peppers, cucumbers, and carrots in the vegetables section. She considered what she still had at home. She _ / only / even bought cucumbers.

19. Felix begutachtet in seinem Garten Erbsen, Bohnen und Zwiebeln. Er pflegte den Garten regelmäßig. Er hat _ / nur / sogar die Erbsen gegossen.

Felix examines peas, beans, and onions in his garden. He took care of the garden regularly. He _ / only / even watered the peas.

20. Mark öffnet eine Dose mit Bonbons, Keksen und Lutschern. Er verspürte Lust auf Süßes. Er hat _/ nur/sogar Kekse gegessen.

Mark has candies, cookies, and lollipops in the jar. He wanted to eat something sweet. He _ / only / even ate cookies.

21. Susanne hat auf ihrem Blumenbeet Rosen, Lilien und Nelken. Sie wollte einen Strauß verschenken. Sie hat _ / nur / sogar die Nelken geschnitten.

Susanne grows roses, lilies, and carnations on her flower bed. She wanted to give someone a bouquet. She _ / only / even used the carnations.

22. Karl jagt auf der Wiese Bienen, Fliegen und Mücken. Er hatte Spaß dabei. Er hat _ / nur / sogar Fliegen gefangen.

Karl chases bees, flies, and mosquitos on the meadow. He had a lot of fun. He _ / only / even caught flies.

23. Isabell notiert auf ihrer Einkaufsliste Käse, Eier und Milch. Sie hatte nicht viel Zeit. Sie hat _/ nur/sogar den Käse vergessen.

Isabell notes cheese, eggs, and milk on her shopping list. She was in a hurry. She _ / only / even forgot to buy cheese.

24. Torsten züchtet auf seinem Bauernhof Hühner, Ziegen und Kühe. Er überlegte, was er bereits erledigt hat. Er hat _ / nur / sogar die Ziegen gefüttert.

Torsten breeds hens, goats, and cows on his farm. He considered what he had already taken care of. He had _ / only / even fed the goats.

25. Lisa sucht im Wald Füchse, Rehe und Igel. Es war eine lange Wanderung. Sie hat _ / nur / sogar Igel gesehen.

Lisa looks for foxes, deer, and hedgehogs in the woods. She had a long walk. She _ / only / even saw hedgehogs.

26. Simon liest im Märchenbuch von Hexen, Prinzen und Drachen. Er las gerne vor dem Einschlafen. Er hat _ / nur / sogar von Hexen geträumt.

Simon reads about witches, princes, and dragons in the storybook. He liked reading before going to bed. He _ / only / even dreamed of witches.

27. Sebastian holt aus dem Wäschekorb Socken, Pullover und Kleider. Er schaute nach, was besonders dreckig war. Er hat _ / nur / sogar die Pullover eingeweicht.

Sebastian takes out socks, sweaters, and dresses from the laundry basket. He checked what was notably dirty. He _ / only / even soaked the sweaters.

28. Paula betrachtet im Schuhgeschäft Stiefel, Sandalen und Turnschuhe. Sie überprüfte, was sie sich leisten kann. Sie hat _ / nur / sogar Turnschuhe anprobiert.

Paula looks at boots, sandals, and sneakers at the shoe shop. She considered what she could afford. She _ / only / even tried on sneakers.

29. Julia durchsucht eine Schublade nach Taschen, Schals und Hüten. Sie wollte aufräumen. Sie hat _/ nur/sogar Taschen aussortiert.

Julia browses her drawer for bags, scarves, and hats. She wanted to tidy up. She _ / only / even sorted out bags.

30. Daniela nimmt aus dem Kühlschrank Äpfel, Birnen und Pflaumen. Sie wollte backen. Sie hat _/ nur/sogar die Birnen abgewaschen.

Daniela takes out apples, pears, and plums from the fridge. She wanted to bake a cake. She he _only/even rinsed pears.

31. Leoni pflanzt auf ihrem Balkon Krokusse, Dahlien und Veilchen. Sie überlegte, was sie noch tun muss. Sie hat _ / nur / sogar die Veilchen gedüngt.

Leoni grows crocuses, dahlias, and violets on her balcony. She wondered what she had to take care of. She _ / only / even gave fertilizer to the violets.

32. Falk findet in seinem Modellbaukasten Züge, Boote und Schiffe. Er überlegte, was er am liebsten machen möchte. Er hat _ / nur / sogar Züge zusammengebaut.

Falk discovers trains, boats, and ships in his model kit. He wondered what he would like to do. He _ / only / even assembled trains.

33. Cornelia findet auf dem Sperrmüll Sofas, Stühle und Truhen. Sie wollte ihre Wohnung umgestalten. Sie hat _ / nur / sogar Stühle mitgenommen.

Cornelia discovers couches, chairs, and chests in the bulk rubbish. She wanted to rearrange her apartment. She _ / only / even took chairs with her.

34. Erik betrachtet im Musikgeschäft Pauken, Flöten und Cellos. Er war auf der Suche nach einem neuen Hobby. Er hat _ / nur / sogar Cellos ausprobiert.

Erik looks at kettledrums, flutes, and cellos in the music store. He was looking for a new hobby. He _ / only / even tried out cellos.

35. Petra legt auf ihren Schreibtisch Füller, Blöcke und Locher. Sie musste etwas vorbereiten. Sie hat _ / nur / sogar Füller benutzt.

Petra puts pens, blocks, and hole punches on her desk. She had to prepare something. She _ / only / even used pens.

36. Robert sucht in seiner Werkstatt nach Zangen, Hämmer und Schrauben. Er suchte eine Weile. Er hat _/ nur/sogar die Zangen gefunden.

Robert searches for pliers, hammers, and screws in his garage. He searched for a while. He _ / only / even found the pliers.

37. Tamara lagert in ihrem Tresor Rubine, Perlen und Saphire. Sie benötigte Geld. Sie hat _ / nur / sogar die Perlen verkauft.

Tamara has rubies, pearls, and sapphires in her vault. She needed some money. She _ / only / even sold the pearls.

38. Klaus trifft auf der Baustelle Maurer, Maler und Schlosser. Er wollte die Arbeit begutachten. Er hat sich _ / nur / sogar mit Schlossern unterhalten.

Klaus meets bricklayers, painters, and locksmiths at the construction site. He wanted to examine the work. He _ / only / even talked to locksmiths.

39. Franziska sucht im Badezimmer nach Bürsten, Schwämmen und Lappen. Sie wollte putzen. Sie hat _ / nur / sogar die Bürsten gefunden.

Franziska looks for brushes, sponges, and rags in the bathroom. She wanted to clean up. She _ / only / even found brushes.

40. Norman sieht im Biologiebuch Herzen, Mägen und Nieren. Er sollte Zeichnungen anfertigen. Er hat _ / nur / sogar Nieren abgezeichnet.

Norman sees hearts, stomachs, and kidneys in the biology book. He had to make drawings. He _ / only / even copied the kidneys.

41. Saskia trifft auf dem Wochenmarkt Bäcker, Gärtner und Bauern. Sie wollte selbst einen Stand aufmachen. Sie hat sich _ / nur / sogar mit den Bauern abgesprochen

Saskia meets bakers, gardeners, and farmers on the market. She wanted to have her own booth. She _ / only / even talked to the farmers.

42. Ole arbeitet im Theater mit Tänzern, Sängern und Künstlern. Er plante eine neue Aufführung. Er hat _ / nur / sogar Tänzer engagiert.

Ole works together with dancers, singers, and artists at the theatre. He was planning a new show. He _ / only / even hired dancers.

43. Dominik trifft bei der Weltmeisterschaft Ringer, Läufer und Schwimmer. Er wollte eine Reportage drehen. Er hat _ / nur / sogar die Schwimmer interviewt.

Dominik meets wrestlers, runners, and swimmers at the Olympic games. He wanted to do a report. He _ / only / even interviewed the swimmers.

44. Susanne benötigt für ihr Auto Reifen, Bremsen und Felgen. Sie muss durch den TüV kommen. Sie hat _ / nur / sogar die Bremsen erneuert.

Susanne needs tires, brakes, and wheels for her car. She had to pass the inspection. She _ / only / even renewed the brakes.

45. Maik sucht auf der Landkarte China, Peru und Indien. Er wollte sehen, wo er schon gewesen ist. Er hat sich _ / nur / sogar an Indien erinnert.

Maik looks for China, Peru, and India on the map. He wanted to see where he had already been. He _ / only / even remembered India.

A.3 Items used in Experiment 4

1. Der Firmenchef erhielt eine Warensendung mit Kleidung. Er hatte _ / nur / auch Hemden bestellt. Er war immer gut gekleidet.

The company boss received a consignment with clothes. He had _ / only / also ordered shirts. He was always well-dressed.

2. Carsten wollte gern Obst essen und griff in einen Korb. Er nahm sich _ / nur / auch Äpfel heraus. Er ernährte sich stets ausgewogen.

Carsten wanted to eat fruit and reached into a basket. He _ / only / also took out apples. He always lived on a balanced diet.

3. Die Hausfrau holte Getränke aus dem Keller. Sie brachte _ / nur / auch Säfte mit. Dann holte sie ein Glas.

The housewife fetched drinks from the basement. She _ / only / also brought juices. Then she got a glass.

4. Peter ging in den Zoo um sich Tiere anzusehen. Er schaute sich _ / nur / auch Affen an. Er drehte eine große Runde.

Peter went to the zoo to watch animals. He _ / only / also watched apes. He went for a big tour.

5. Jens suchte in seinem Schrank nach Werkzeugen. Er entdeckte _ / nur / auch Sägen darin. Er wollte das Haus verschönern.

Jens looked for tools in his cupboard. He _ / only / also discovered saws in it. He wanted to embellish the house.

6. Sarah durchsuchte einen Karton mit Büromaterialien. Sie fand _ / nur / auch Füller darin. Sie musste wieder aufräumen.

Sarah searched through a cardboard box with stationary. She _ / only / also found pens in it. She had to tidy up again.

7. Die Musiklehrerin wählte Instrumente für ihren Unterricht aus. Sie probierte _ / nur / auch Geigen aus. Sie musste den Unterricht vorbereiten.

The music teacher chose instruments for her class. She _ / only / also tried out violins. She had to prepare the class.

8. Karo schaute sich den Schmuck in ihrer Schatulle an. Sie nahm _ / nur / auch Ringe heraus. Dann wählte sie ihr Outfit.

Karo looked at the jewellery in her casket. She _ / only / also took out rings. Then she chose her outfit.

9. Markus ging in seinen Schuppen um Gartengeräte zu säubern. Er holte _ / nur / auch Harken heraus. Er wollte später Gartenarbeit verrichten.

Markus went into his shed to clean gardening tools. He _ / only / also took out rakes. He wanted to do gardening work later.

10. Tamara begutachtete die Wertsachen in ihrem Tresor. Sie nahm _ / nur / auch Perlen heraus. Dann erneuerte sie die Zahlenkombination.

Tamara examined the valuables in her safe. She _ / only / also took out pearls. Then she renewed the safety code.

11. Der Jugendliche schaute sich im Museum die Waffen an. Er wollte _ / nur / auch Speere dokumentieren. Er sollte einen Bericht schreiben.

The teenager looked at the weapons in the museum. He _ / only / also wanted to document spears. He was supposed to write a report.

12. Michaela überprüfte die Hygieneartikel in ihrem Badschrank. Sie sortierte _ / nur / auch Seife aus. Sie wollte wieder Platz schaffen.

Michaela checked the sanitary products in her bathroom shelf. She _ / only / also threw away soap. She wanted to get some space.

13. Anna schaute im Prospekt nach Möbeln. Sie markierte _ / nur / auch Schränke darin. Sie ging anschließend ins Geschäft.

Anna looked for furniture in the brochure. She _ / only / also marked cupboards in it. Afterwards she went into the shop.

14. Maria sortierte das Geschirr in ihrem Spülbecken. Sie stellte _ / nur / auch Teller weg. Sie war mit Küchendienst dran.

Maria sorted the dishes in her (kitchen) sink. She _ / only / also put plates away. It was her turn to do the kitchen service.

15. Max betrachtete das Spielzeug in seinem Kinderzimmer. Er wollte _ / nur / auch Bälle verschenken. Er hatte zu wenig Platz.

Max looked at the toys in his nursery. He _ / only / also wanted to give balls away. He didn‘t have enough space.

16. Der Schüler sah Abbildungen von Organen im Biologiebuch. Er betrachtete _ / nur / auch Herzen genau. Er bereitete seine Prüfung vor.

The pupil saw images of organs in the biology text book. He _ / only / also studied hearts. He prepared his examination.

17. Der Elektrofachmann leitete ein Geschäft mit Küchengeräten. Er bot _ / nur / auch Toaster an. Er schaute nach dem Warenstand.

The electro professional ran a business with kitchen equipment. He _ / only / also offered toasters. He checked the assortment of goods.

18. Katharina legte Gemüse in ihren Einkaufswagen. Sie wollte _ / nur / auch Möhren kaufen. Sie ging schnell zur Kasse.

Katharina put vegetables into her shopping trolley. She _ / only / also wanted to buy carrots. She went quickly to the cash desk.

19. Felix züchtete Gemüse in seinem Garten. Er baute _ / nur / auch Erbsen an. Er hatte einen grünen Daumen.

Felix grew vegetables in his garden. He _ / only / also grew peas. He had green fingers.

20. Mark sammelte Süßigkeiten in einer Dose. Er bewahrte darin _ / nur / auch Bonbons auf. Er naschte hin und wieder.

Mark collected sweets in a can. He _ / only / also kept candies in it. He nibbled from time to time.

21. Susanne kümmerte sich um die Blumen auf ihrem Beet. Sie hatte _ / nur / auch Nelken gepflanzt. Sie mochte Gartenarbeit sehr gern.

Susanne took care of the flowers on her patch. She had _ / only / also planted cloves. She liked gardening very much.

22. Karl haschte auf der Wiese nach Insekten. Er fing _ / nur / auch Fliegen dabei. Er tobte den ganzen Tag herum.

Karl hunted for insects on the meadow. He _ / only / also caught flies. He romped around the whole day.

23. Isabell guckte nach den Milchprodukten auf ihrer Einkaufsliste. Sie hatte _ / nur / auch Käse aufgeschrieben. Sie holte einen Einkaufswagen.

Isabell was checking the dairy products on her shopping list. She had _ / only / also noted cheese. She fetched a shopping trolley.

24. Der Bauer kümmerte sich um die Nutztiere auf seinem Hof. Er hatte _ / nur / auch Schweine zur Zucht. Er arbeitete gern im Stall.

The farmer took care of the farm animals on his farm. He _ / only / also had pigs in his breeding. He liked to work in the stable.

25. Der Jäger sah sich im Wald nach Wildtieren um. Er wollte _ / nur / auch Rehe schießen. Er legte das Gewehr an.

The hunter was looking around for wild animals in the forest. He _ / only / also wanted to shoot deer. He raised the gun to his shoulder.

26. Der Junge betrachtete die Märchenfiguren in seinem Buch. Er hat _ / nur / auch Hexen gesehen. Er gruselte sich beim Lesen.

The boy was looking at the fairytale figures in his book. He had _ / only / also seen witches. He was scared while reading.

27. Sebastian ordnete die Kleidungsstücke in seinem Wäschekorb. Er wollte _ / nur / auch Hosen waschen. Er machte eine Ladung fertig.

Sebastian arranged the clothes in his clothes basket. He _ / only / also wanted to wash pants. He got a load ready.

28. Paula suchte sich auf dem Sperrmüll Möbelstücke aus. Sie wollte _ / nur / auch Sofas mitnehmen. Ihre Freunde wollten ihr helfen.

Paula picked out items of furniture from the bulk trash. She _ / only / also wanted to take along sofas. Her friends wanted to help her.

29. Daniela holte Obst aus ihrem Kühlschrank. Sie wählte _ / nur / auch Birnen aus. Sie wollte etwas Frisches essen.

Daniela got fruits out of her fridge. She _ / only / also chose pears. She wanted to eat something fresh.

30. Markus suchte in seiner Werkstatt nach Ersatzteilen. Er wollte _ / nur / auch Felgen austauschen. Er suchte ein ganze Weile.

Markus was looking for spare parts in his garage. He _ / only / also wanted to exchange rims. He was searching for quite a while.

31. Josi wollte sich um die Tiere im Stall kümmern. Sie hat _ / nur / auch Pferde gefüttert. Dann ging sie ins Haus.

Josi wanted to care of the animals in the stable. She _ / only / also fed horses. Then she went into the house.

32. Der Hausmeister suchte im Keller nach Putzutensilien. Er fand _ / nur / auch Eimer dort. Er wollte den Hof säubern.

The caretaker was looking for cleaning utensils in the basement. There he _ / only / also found buckets. He wanted to clean the yard.

33. Janine wollte auf dem Flohmarkt Dekoartikel kaufen. Sie nahm _ / nur / auch Lampen mit. Sie war zufrieden beim Einkauf.

Janine wanted to buy decoration items at the flea market. She _ / only / also got lamps. She was satisfied with the purchase.

34. Torsten verkaufte auf dem Wochenmarkt Wurstwaren. Er hatte _ / nur / auch Schinken im Angebot. Es war ein erfolgreicher Tag.

Torsten sold sausage products at the weekly market. He _ / only / also had ham on offer. It was a successful day.

35. Die Intendantin besuchte ihre Mitarbeiter im Schauhaus. Sie traf _ / nur / auch Tänzer an. Sie besprach das neue Programm.

The director visited her employees at the theatre. She _ / only / also met dancers. She discussed the new programme.

36. Dominik sah bei der Weltmeisterschaft Sportler. Er hat sich _ / nur / auch Läufer angeschaut. Er klatschte oft begeistert Beifall.

Dominik saw athletes at the world championship. He _ / only / also watched runners. He often applauded enthusiastically.

37. Susanne suchte am Meer nach Schalentieren. Sie wollte _ / nur / auch Krebse untersuchen. Sie war von Beruf Biologin.

Susanne was looking for shellfishes at the sea. She _ / only / also wanted to examine crabs. She was biologist by profession.

38. Leoni pflanzte auf ihrem Balkon Blumen. Sie hat _ / nur / auch Rosen umgetopft. Sie wollte außerdem neue Töpfe kaufen.

Leoni planted flowers on her balcony. She _ / only / also repotted roses. Furthermore she wanted to buy new pots.

39. Paula hatte einen Schrank für Accessoires. Sie bewahrte darin _ / nur / auch Gürtel auf. Sie wollte bald alles aufräumen.

Paula had a cupboard for accessories. She _ / only / also stored belts in it. She wanted to tidy up everything soon.

40. Julia öffnete eine Schublade mit Accessoires. Sie holte _ / nur / auch Tücher heraus. Sie wählte ihr Outfit aus.

Julia opened a drawer with accessories. She _ / only / also got scarves out of it. She chose her outfit.

41. Der Hotelchef kündigte ein paar Mitarbeitern. Er hat _ / nur / auch Kellnern gekündigt. Er tat dies im Gespräch.

The hotel boss dismissed some employees. He _ / only / also dismissed waiters. He held personal conversations.

42. Der Biologe untersuchte die Probe nach Krankheitserregern. Er fand _ / nur / auch Viren darin. Er notierte sich alle Werte.

The biologist examined the sample for pathogens. He _ / only / also found viruses in it. He noted all the data.

43. Vinzent erkundete Tierbauten im Naturschutzgebiet. Er hat _ / nur / auch Nester untersucht. Er war ein echter Naturfreund.

Vinzent explored dens of animals in the nature reserve. He _ / only / also examined nests. He was a true nature lover.

44. Cornelia sah auf dem Sperrmüll Möbelstücke. Sie wählte _ / nur / auch Stühle aus. Ihre Freunde halfen beim Tragen.

Cornelia saw furniture items on the bulk rubbish. She _ / only / also selected chairs. Her friends helped her carrying.

45. Erik schaute sich in der Musikschule Instrumente an. Er fand _ / nur / auch Harfen spannend. Er wollte einen Kurs belegen.

Erik looked at the instruments at the music school. He _ / only / also found harps exciting. He wanted to attend a course.

46. Petra ordnete die Büromateralien auf ihrem Schreibtisch. Sie sortierte _ / nur / auch Hefter aus. Dann ging sie noch einkaufen.

Petra arranged the stationary at her desk. She _ / only / also sorted out files. Then she went shopping.

47. Robert durchsuchte die Kleinteile in seiner Werkstatt. Er musste _ / nur / auch Schrauben finden. Er wollte etwas basteln.

Robert searched for sundries in his factory. He _ / only / also had to find screws. He wanted to do handicrafts.

48. Klaus suchte auf dem Grundstück nach Handwerkern. Er traf dort _ / nur / auch Maurer an. Er fragte nach dem Stand.

Klaus was looking for craftsmen on the site. He _ / only / also met masons. He was asking for the state of things.

49. Kim suchte im Elektrogeschäft nach Elektrogeräten. Sie wollte sich _ / nur / auch Trockner anschauen. Die Beratung fand sie hilfreich.

Kim was looking for appliances in the electrical shop. She _ / only / also wanted to have a look at driers. She found the consultation helpful.

50. Ralf brachte vom Einkaufsladen Lebensmittel mit. Er hat _ / nur / auch Eier gekauft. Er wollte später noch backen.

Ralf brought groceries from the supermarket. He had _ / only / also bought eggs. Later he wanted to bake.

51. Sina wollte Backwaren beim Bäcker kaufen. Sie brachte _ / nur / auch Brötchen mit. Sie wollte mit Freunden frühstücken.

Sina wanted to buy baked goods at the bakery. She _ / only / also bought buns. She wanted to have breakfast with her friends.

52. Sophie musste für ihre Prüfung Organe lernen. Sie bereitete _ / nur / auch Lungen vor. Sie hatte Angst vor der Prüfung.

Sophie had to learn about organs for her examination. She _ / only / also studied lungs. She was scared about the examination.

53. Der Sportlehrer holte Geräte aus dem Geräteraum. Er brachte _ / nur / auch Seile mit. Er ordnete alles akkurat.

The P.E. teacher took equipment from the equipment room. He _ / only / also brought ropes. He arranged everything accurately.

54. Klara begegnete in ihrem Haus Handwerkern. Sie traf _ / nur / auch Klempner an. Die Leitungen waren wieder verstopft.

Klara met craftsmen in her house. She _ / only / also met plumbers. The pathways were blocked up again.

55. Franziska suchte im Badezimmer nach Putzutensilien. Sie fand _ / nur / auch Schwämme dabei. Das Bad sollte blitzsauber sein.

Franziska was looking for cleaning utensils in the bathroom. There she _ / only / also found sponges. The bathroom was supposed to be spanking clean.

56. Der Baumeister begutachtete die Fahrzeuge auf der Baustelle. Er wollte _ / nur / auch Bagger überprüfen. Er fand keine technischen Mängel.

The builder examined the vehicles at the construction site. He _ / only / also wanted to check on diggers. He found no technical defects.

57. Die Kindergärtnerin erstellte ein Plakat mit Märchenfiguren. Sie hatte _ / nur / auch Prinzen gezeichnet. Sie zeigte dies den Kindern.

The kindergardener made a poster with fairytale figures. She had _ / only / also drawn princes. She showed this to the children.

58. Daniela hatte einen Korb mit Früchten. Sie bewahrte darin _ / nur / auch Kirschen auf. Sie hatte einen schönen Garten.

Daniela had a basket with fruits. She _ / only / also kept cherries in it. She had a beautiful garden.

59. Manuela brauchte für ihre Klasse neues Sportzubehör. Sie hat _ / nur / auch Matten bestellt. Sie war eine begeisterte Lehrerin.

Manuela needed new sport supplies for her class. She _ / only / also ordered mats. She was an enthusiastic teacher.

60. Falk hatte in seinem Modellbaukasten Fahrzeuge. Er bewahrte darin _ / nur / auch Züge auf. Er spielte mit seinem Vater.

Falk had vehicles in his model kit. He _ / only / also kept trains in it. He played with his father.

A.4 Items used in Experiments 5 and 6

1. Die Lehrer und die Eltern waren bei der Versammlung. Auch / Nur / _ die Eltern hatte einige Anmerkungen. Sie begannen die Diskussion.

The teachers and the parents were at the assembly. Also / Only / _ the parents had some remarks. They started the discussion.

2. Der Prediger und der Gläubige unterhielten sich über die Kapelle. Auch / Nur / _ der Gläubige spendete für den Umbau. Er unterstützte viele Projekte.

The preacher and the believer talked about the chapel. Also / Only / _ the believer donated for the reconstruction. He supported many projects.

3. Die Jungen und die Mädchen spielten auf dem Schulhof. Auch / Nur / _ die Jungen wollten Versteck spielen. Sie begannen zu zählen.

The boys and the girls played at the schoolyard. Also / Only / _ the boys wanted to play hide-and-seek. They started counting.

4. Der Schauspieler und der Kabelträger gerieten in einen Streit. Auch / Nur / _ der Schauspieler wollte die Arbeit hinwerfen. Er beschwerte sich ausgiebig.

The actor and the cable carrier incurred in a dispute. Also / Only / _ the actor wanted to chuck the work. He complained a lot.

5. Der Produzent und der Regisseur besprachen den neuen Film. Auch / Nur / _ der Regisseur war mit dem Drehbuch unzufrieden. Er wollte Änderungen vornehmen .

The producer and the director discussed the new movie. Also / Only / _ the director was displeased with the script. He decided to make some changes.

6. Der Architekt und der Ingenieur wohnten im selben Haus. Auch / Nur / _ der Architekt wollte Renovierungsarbeiten durchführen. Er machte einen Vorschlag.

The architect and the engineer lived in the same house. Also / Only / _ the architect wanted to do renovation works. He made a suggestion.

7. Der Dirigent und der Komponist studierten an derselben Hochschule. Auch / Nur / _ der Komponist machte einen erfolgreichen Abschluss. Er wurde sehr bekannt.

The conductor and the composer studied at the same college. Also / Only / _ the composer graduated successfully. He became famous.

8. Der Gitarrist und der Schlagzeuger trafen sich im Proberaum. Auch / Nur / _ der Gitarrist war gut auf die Probe vorbereitet. Er spielte sehr professionell.

The guitarist and the drummer met in the rehearsal room. Also / Only / _ the guitarist was well prepared for the rehearsal. He played very professionally.

9. Die Ärztin und die Schwester trafen sich in der Kantine. Auch / Nur / _ die Schwester wollte Salat essen. Sie ernährte sich gesund.

The doctor and the nurse met in the canteen. Also / Only / _ the nurse wanted to eat salad. She was on a healthy diet.

10. Der Sänger und der Texter arbeiteten am neuen Stück. Auch / Nur / _ der Texter war zufrieden mit der bisherigen Arbeit. Er machte früh Feierabend.

The singer and the songwriter worked on a new musical piece. Also / Only / _ the songwriter was satisfied with the previous work. He finished work early.

11. Der Engländer und der Franzose nahmen an einer Fernsehshow teil. Auch / Nur / _ der Engländer wandte sich ans Publikum. Er hatte einige Kritikpunkte.

The Englishman and the Frenchman took part in a TV show. Also / Only / _ the Englishman turned to the audience. He had some points of criticism.

12. Der Fotograf und das Topmodel arbeiteten an der Fotostrecke. Auch / Nur / _ das Topmodel war hochmotiviert. Sie machte gute Arbeit.

The photographer and the supermodel worked for a photo series. Also / Only / _ the supermodel was very motivated. She did a good job.

13. Der Verkäufer und der Experte unterhielten sich im Geschäft. Auch / Nur / _ der Experte begeisterte sich für die Ware. Er erstellte ein Prospekt.

The seller and the expert talked in the shop. Also / Only / _ the expert was enthusiastic about the products. He designed a brochure.

14. Der Richter und der Zeuge verfolgten die Beweisführung. Auch / Nur / _ der Richter glaubte dem Angeklagten. Er verkündete das Urteil.

The judge and the witness followed the argument. Also / Only / _ the judge believed the defendant. He announced the verdict.

15. Die Tochter und die Mutter saßen am Frühstückstisch. Auch / Nur / _ die Tochter wollte ein ausgiebiges Frühstück. Sie bereitete alles vor.

The daughter and the mother sat at the kitchen table. Also / Only / _ the daughter wanted to have a substantial breakfast. She prepared everything.

16. Der Schneider und der Tischler begutacheten die Anfertigung. Auch / Nur / _ der Tischler war zufrieden mit der Verarbeitung. Er gab sein OK.

The tailor and the carpenter looked the production. Also / Only / _ the carpenter was satisfied with the workmanship. He gave his OK.

17. Der Meister und der Kunde unterhielten sich über die Ausbildung. Auch / Nur / _ der Meister war einverstanden mit der Vorgehensweise. Er begann zu arbeiten.

The master and the client talked about the apprenticeship. Also / Only / _ the master agreed with the procedure. He started working.

18. Der Anwalt und der Klient besprachen den Fall. Auch / Nur / _ der Klient war mit der Einigung einverstanden. Er unterschrieb den Vertrag.

The lawyer and the client discussed the case. Also / Only / _ the client agreed with the settlement. He signed the contract.

19. Der Fleischer und der Bäcker waren Freunde. Auch / Nur / _ der Bäcker kam aus Norddeutschland. Er hatte dort Familie.

The butcher and the baker were friends. Also / Only / _ the baker came from Northern Germany. He had family there.

20. Der Notar und der Schreiber besprachen die Urlaubsplanung. Auch / Nur / _ der Notar wollte im Winter Urlaub nehmen. Er buchte eine Reise.

The solicitor and the writer discussed the vacation planning. Also / Only / _ the solicitor wanted to take vacation in wintertime. He booked a trip.

21. Der Doktor und der Patient besprachen die Behandlung. Auch / Nur / _ der Patient wollte sich eine zweite Meinung einholen. Er ging zur Krankenkasse.

The doctor and the patient discussed the treatment. Also / Only / _ the patient wanted to take a second opinion. He went to the office of the health insurance.

22. Die Dozentin und die Studentin gingen zur Konferenz. Auch / Nur / _ die Dozentin war von den Vorträgen begeistert. Sie klatschte lange Beifall.

The lecturer and the student went to the conference. Also / Only / _ the lecturer was enthusiastic about the talks. She applauded for a long time.

23. Die Spanierin und die Ungarin gingen zum Fest. Auch / Nur / _ die Ungarin aß eine große Portion. Sie holte sich Nachschlag.

The Spaniard and the Hungarian went to the celebration. Also / Only / _ the Hungarian ate a large portion. She went to get a second serving.

24. Der Polizist und der Detektiv waren am Tatort. Auch / Nur / _ der Polizist nahm Fingerabdrücke auf. Er ging aufs Revier.

The police officer and the detective were at the scene of crime. Also / Only / _ the police officer took finger prints. He went to the police station.

25. Der Techniker und der Maschinist berieten den Umbau. Auch / Nur / _ der Techniker hatte gute Vorschläge. Er berichtete seinem Chef.

The technical engineer and the machinist discussed the reconstruction. Also / Only / _ the technical engineer had good suggestions. He reported to his boss.

26. Die Schwedin und die Portugiesin nahmen am Wettbewerb teil. Auch / Nur / _ die Portugiesin war mit ihrer Leistung zufrieden. Sie erhielt eine Auszeichnung.

The Swede and the Portuguese took part in the competition. Also / Only / _ the Portuguese was satisfied with her performance. She received an award.

27. Die Gymnastin und die Athletin waren bei der Weltmeisterschaft. Auch / Nur / _ die Gymnastin reiste mit ihrer Trainerin. Sie war gut vorbereitet.

The gymnast and the athlete were at the world championship. Also / Only / _ the gymnast travelled with her coach. She was well prepared.

28. Der Schwimmer und der Läufer gewannen die Olympiade. Auch / Nur / _ der Läufer feierte seinen Erfolg ausgiebig. Er öffnete einen Sekt.

The swimmer and the runner won the Olympic Games. Also / Only / _ the runner celebrated his success. He opened a bottle of champagne.

29. Die Dichterin und die Kritikerin nahmen an der Lesung teil. Auch / Nur / _ die Dichterin hörte aufmerksam zu. Sie stellte anschließend Fragen.

The poet and the critic joined the reading. Also / Only / _ the poetess listened attentive. Afterwards she asked questions.

30. Die Chemikerin und die Physikerin waren bei der Nobelpreisverleihung. Auch / Nur / _ die Physikerin war nominiert. Sie erhielt die Auszeichnung.

The chemist and the physicist were at the Nobel Prize ceremony. Also / Only / _ the physicist was nominated. She received the award.

31. Der Adler und der Falke waren Rivalen. Auch / Nur / _ der Adler hatte die Beute erspäht. Er ging auf Sturzflug.

The eagle and the hawk were rivals. Also / Only / _ the eagle espied the quarry. He nosedived.

32. Der Schuster und der Maler gingen zusammen zur Schule. Auch / Nur / _ der Maler war gut in Mathe. Er war der Klassenbeste.

The cobbler and the painter went to school together. Also / Only / _ the painter was good in maths. He was the top of the class.

33. Die Hebamme und die Erzieherin unterhielten sich beim Arzt. Auch / Nur / _ die Hebamme betreute ihr eigenes Kind selbst. Sie war glücklich damit.

The midwife and the educator talked at the doctors. Also / Only / _ the midwife parented her child on her own. She was happy about that.

34. Der Archäologe und der Zoologe besprachen den antiken Fund. Auch / Nur / _ der Zoologe berichtete seinen Fachkollegen davon. Er ging zurück ins Büro.

The archeologist and the zoologist discussed the antique finding. Also / Only / _ the zoologist reported to his collegue. He went back to the office.

35. Der Historiker und der Philosoph liefen sich über den Weg. Auch / Nur / _ der Historiker war an einer Zusammenarbeit interessiert. Er machte einen Termin.

The historian and the philosopher crossed their paths. Also / Only / _ the historian was interested in collaboration. He made an appointment.

36. Der Journalist und der Redakteur trafen sich in der Kaffeeecke. Auch / Nur / _ der Redakteur wollte Veränderungen am Artikel vornehmen. Er fragte seinen Vorgesetzten.

The journalist and the editor met at the coffee corner. Also / Only / _ the editor wanted to make some changes at the article. He asked his superior.

37. Der Manager und der Designer unterhielten sich auf der Party. Auch / Nur / _ der Manager trank Wein. Er holte eine Flasche.

The manager and the designer talked at the party. Also / Only / _ the manager drank vine. He got a bottle.

38. Der Betriebswirt und der Volkswirt erstellten einen Plan. Auch / Nur / _ der Volkswirt brachte revolutionäre Vorschläge. Er war ein Experte.

The business manager and the economist created a plan. Also / Only / _ the economist made revolutionary suggestions. He was an expert.

39 Der Postbote und der Gehilfe verteilten Briefe. Auch / Nur / _ der Postbote wollte eine Pause machen. Er machte den Vorschlag.

The mailman and the assistant distributed letters. Also / Only / _ the mailman wanted to have a break. He made the suggestion.

40. Die Dänin und die Polin nahmen an einem Sprachkurs teil. Auch / Nur / _ die Polin wollte eine gute Note schreiben. Sie lernte mehrere Wochen.

The Danish woman and the Polish attended a language course. Also / Only / _ the Polish wanted to get a good grade. She studied for many weeks.

41. Die Gärtnerin und die Floristin unterhielten sich über Pflanzen. Auch / Nur / _ die Gärtnerin war glücklich mit ihrer Berufswahl. Sie mochte Blumen sehr.

The gardener and the florist talked about plants. Also / Only / _ the gardener was happy about her choice of profession. She liked flowers very much.

42. Der Lektor und der Autor korrigierten das Manuspkript. Auch / Nur / _ dem Autor fielen die Kommafehler auf. Er verbesserte den Text.

The editor and the author corrected the manuscript. Also / Only / _ the author noticed the (comma) typos. He corrected the text.

43. Der Büroleiter und der Angestellte diskutierten den Arbeitsvertrag. Auch / Nur / _ der Büroleiter war glücklich über die Einigung. Er unterschrieb den Vertrag.

The office manager and the employee discussed the working contract. Also / Only / _ the office manager was happy about the agreement. He signed the contract.

44. Der Stabhochspringer und der Diskuswerfer wollten ins Finale kommen. Auch / Nur / _ der Diskuswerfer brach seinen eigenen Rekord. Er hatte viel trainiert.

The pole jumper and the discus thrower wanted to reach the final. Also / Only / _ the discus thrower broke his record. He trained a lot.

45. Die Zahnärztin und die Assistentin inspizierten die Praxis. Auch / Nur / _ die Assistentin wollte die Praxis umgestalten. Sie stellte die Geräte um.

The dentist and the assistant inspected the practice. Also / Only / _ the assistant wanted to redesign the practice. She relocated the devices.

46. Der Kardiologe und der Dermatologe arbeiteten im selben Krankenhaus. Auch / Nur / _ der Dermatologe musste Nachtdienst machen. Er war schon übermüdet.

The cardiologist and the dermatologist worked at the same hospital. Also / Only / _ the dermatologist had to do night service. He was overtired.

47. Der Chauffeur und der Prominente fuhren in der Limousine. Auch / Nur / _ der Chauffeur öffnete sein Fenster. Er brauchte frische Luft.

The driver and the celebrity drove in the limousine. Also / Only / _ the driver opened his window. He needed fresh air.

48. Der Zimmermann und der Handwerker nahmen am Richtfest teil. Auch / Nur / _ der Handwerker brachte ein Geschenk mit. Er blieb bis zum Ende.

The carpenter and the craftsman participated at the topping-out ceremony. Also / Only / _ the carpenter brought a gift. He stayed until the end.

49. Die Kassiererin und die Leiterin unterhielten sich über die neue Filiale. Auch / Nur / _ die Kassiererin war gegen die Eröffnung. Sie wollte offiziell streiken.

The cashier and the manager talked about a new chain store. Also / Only / _ the cashier was opposed to the opening. She wanted to go on an official strike.

50. Der Konditor und der Geselle eröffneten eine Filiale. Auch / Nur / _ der Geselle investierte viele Stunden. Er war deshalb erschöpft.

The confectioner and the assistant opened the new chain store. Also / Only / _ the assistant invested many hours. Therefore he was exhausted.

51. Der Kontrolleur und der Zugführer trafen sich bei der Endhaltestelle. Auch / Nur / _ der Zugführer war hungrig. Er ging ins Bistro.

The ticket inspector and the conductor met at the terminus. Also / Only / _ ticket inspector was hungry. He went to the bistro.

52. Der Koch und der Kellner trafen sich in der Mittagspause. Auch / Nur / _ der Koch beschwerte sich über den Chef. Er war sehr aufgebracht.

The cook and the waiter met during lunch break. Also / Only / _ the cook complained about the boss. He was very enraged.

53. Die Forscherin und die Laborantin untersuchten die Stammzellen. Auch / Nur / _ die Laborantin war von den Ergebnissen fasziniert. Sie schrieb einen Artikel.

The scientist and the laboratory assistant analysed the stem cells. Also / Only / _ the laboratory assistant was fascinated by the results. She wrote an article.

54. Der Matrose und der Kapitän beluden das Schiff. Auch / Nur / _ der Matrose war fleißig bei der Arbeit. Er ging unter Deck.

The sailor and the captain charged the ship. Also / Only / _ the sailor was working diligently. He went below deck.

55. Der Friseur und der Stylist waren auf der Modemesse. Auch / Nur / _ der Friseur konnte sich kaum vor Aufträgen retten. Er verdiente viel Geld.

The hairdresser and the stylist were at the fashion fair. Also / Only / _ the hairdresser could barely rescue himself of jobs. He earned lots of money.

56. Der Förster und der Jäger suchten im Wald nach Wildtieren. Auch / Nur / _ der Förster sah ein Reh. Er zog sein Gewehr.

The ranger and the hunter searched for wild animals in the forest. Also / Only / _ the ranger saw a deer. He pulled his rifle.

57. Der Geologe und der Biologe gingen auf Exkursion. Auch / Nur / _ der Biologe entnahm eine Bodenprobe. Er verwendete eine Petrischale.

The geologist and the biologist went on an excursion. Also / Only / _ the biologist extracted a sample of the soil. He used a petri dish.

58. Die Dolmetscherin und die Referentin arbeiteten bei einem Kongress. Auch / Nur / _ die Dolmetscherin brauchte eine Pause. Sie machte ein Handzeichen.

The interpreter and the speaker worked at a congress. Also / Only / _ the interpreter needed a break. She gave a hand signal.

59. Der Masseur und der Therapeut sprachen über den Patienten. Auch / Nur / _ der Therapeut war zufrieden mit den Fortschritten. Er verlängerte die Behandlung.

The masseur and the therapist talked about the patient. Also / Only / _ the therapist was satisfied with the progress. He prolonged the treatment.

60. Der Offizier und der Soldat unterhielten sich über ihre Einsätze. Auch / Nur / _ der Offizier war schon im Iran gewesen. Er erinnerte sich zurück.

The officer and the soldier talked about their operations. Also / Only / _ the officer had been to Iran. He remembered that.

61. Die Chinesin und die Japanerin lernten fürs Examen. Auch / Nur / _ die Japanerin wollte eine gute Note schreiben. Sie lernte viele Wochen.

The Chinese and the Japanese studied for the exam. Also / Only / _ the Japanese wanted to get a good grade. She studied for many weeks.

62. Die Christin und die Jüdin nahmen am Religionsunterricht teil. Auch / Nur / _ die Christin war tolerant gegenüber anderen Religionen. Ihre Eltern waren liberal.

The Christian and the Jew participated in the religion class. Also / Only / _ the Christian was tolerant towards other religions. Her parents were liberal.

63. Der Spieler und der Torwart waren gespannt auf den Endgegner. Auch / Nur / _ der Spieler erzielte in dieser Saison Bestleistungen. Er hatte viel trainiert.

The player and the goal keeper were curious about the final opponent. Also / Only / _ the player achieved best performances this season. He had trained a lot.

64. Der Fluglotse und der Copilot koordinierten die Landung. Auch / Nur / _ der Copilot sah bereits vorher die Schwierigkeiten. Er informierte die Zentrale.

The air traffic controller and the co-pilot coordinated the landing. Also / Only / _ the co-pilot already saw the difficulties. He informed the head quarter.

65. Die Pilotin und die Stewardess sprachen über die Route. Auch / Nur / _ die Stewardess war schonmal in Afrika gewesen. Sie hatte viel Berufserfahrung.

The pilot and the stewardess talked about the route. Also / Only / _ the stewardess has been to Africa already. She had a lot professional experience.

66. Der Bankkaufmann und der Buchhalter sprachen über die Börsenkurse. Auch / Nur / _ der Bankkaufmann hatte ein gutes Gespür für neue Aktien. Er machte großen Gewinn.

The banker and the book keeper talked about the market-prices. Also / Only / _ the banker had a good sense for new stocks. He made a huge profit.

67. Der Boxer und der Jogger trainierten auf Kondition. Auch / Nur / _ der Jogger trainierte mit Seilspringen. Er war sehr fit.

The boxer and the runner exercised on endurance. Also / Only / _ the runner trained by rope skipping. He was very fit.

68. Die Königin und die Prinzessin planten zusammen die Hochzeit. Auch / Nur / _ die Königin wollte die gesamte Verwandtschaft einladen. Sie war ein Familienmensch.

The queen and the princess planed the wedding together. Also / Only / _ the queen wanted to invite all of the relatives. She was a family person.

69. Der Hofnarr und der Baron unterhielten sich über das Fest. Auch / Nur / _ der Baron hatte sich gut amüsiert. Er tanzte ohne Pause..

The jester and the baron talked about the celebration. Also / Only / _ the baron had amused himself well. He danced without a break.

70. Der Münchner und der Hamburger waren beim Volksfest. Auch / Nur / _ der Münchner mochte volkstümliche Musik. Er sang laut mit.

The inhabitant of Munich and the inhabitant of Hamburg were at the public festival. Also / Only / _ the Munich liked folk music. He joined in singing loudly.

71. Der Schiedsrichter und der Handballer stritten sich um das Tor. Auch / Nur / _ der Schiedsrichter geriet in Rage. Er zog eine Karte.

The referee and the handball player argued about the goal. Also / Only / _ the referee got furious. He pulled a card.

72. Der Fahrer und der Passagier stritten sich im Taxi. Auch / Nur / _ der Passagier wollte die Fahrt beenden. Er war ganz aufgebracht.

The driver and the passenger had a fight in the taxi. Also / Only / _ the passenger wanted to end the ride. He was very upset.

73. Der Fußballer und der Kugelstoßer trainierten auf dem gleichen Sportplatz. Auch / Nur / _ der Fußballer ging jeden morgen hin. Er spielte im Verein.

The soccer player and the shot-putter practised at the same sports field. Also / Only / _ the soccer player went there every morning. He played in a club.

74. Der Lehrling und der Pfleger behandelten die Frau. Auch / Nur / _ der Pfleger machte sich Sorgen um die Genesung. Er kannte sie lange.

The trainee and the (male) nurse treated the woman. Also / Only / _ the (male) nurse was worried about the recovery. He knew her for a long time.

75. Der Bräutigam und der Trauzeuge besprachen die Zeromonie. Auch / Nur / _ der Bräutigam hatte Angst etwas zu vergessen. Er machte sich Notizen.

The groom and the best man discussed the ceremony. Also / Only / _ the groom was afraid of forgetting something. He made notes.

76. Der Bergsteiger und der Tourist gingen zusammen auf Wandertour. Auch / Nur / _ der Tourist war nach einer Weile erschöpft. Er wollte zurückkehren.

The mountaineer and the tourist went on a hiking tour together. Also / Only / _ the tourist was exhausted after a while. He wanted to return.

77. Der Portier und der Hotelgast sprachen an der Eingangstür. Auch / Nur / _ der Portier hatte den Star erkannt. Er wollte ein Autogramm.

The doorman and the hotel guest talked at the entrance door. Also / Only / _ the doorman had recognized the star. He wanted an autograph.

78. Der Mediziner und der Psychologe arbeiteten an der selben Uni. Auch / Nur / _ der Psychologe mochte seinen Campus. Er war viel draußen.

The physician and the psychologist worked at the same university. Also / Only / _ the psychologist liked his campus. He was often outside.

79. Der Bauherr und der Besitzer schauten sich den Schaden an. Auch / Nur / _ der Bauherr wollte die Firma verklagen. Er ging vor Gericht.

The builder and the owner examined the damage. Also / Only / _ the builder wanted to sue the company. He went to court.

80. Der Zauberer und der Dompteur zogen mit dem Zirkus umher. Auch / Nur / _ der Dompteur war von Anfang an dabei. Er mochte seine Arbeit.

The magician and the tamer tramped with the circus. Also / Only / _ the tamer had participated from the beginning. He liked his work.

A.5 Probe words used in Experiments 2 and 3

List of mentioned alternatives, unmentioned alternatives and unrelated items corresponding to the items listed in A.1.

Table A.1: Probes used in Experiments 2 and 3

Item	*mentioned alternative*	*unmentioned alternative*	*unrelated*
1	Hemden	Strümpfe	Litschis
	shirts	socks	lychees
2	Kirschen	Melonen	Keulen
	cherries	melons	clubs
3	Saft	Tee	Teller
	juice	tea	plates
4	Zebras	Pfauen	Eimer
	zebras	peacocks	buckets
5	Feilen	Zangen	Windeln
	files	pliers	diapers
6	Scheren	Radierer	Flöten
	scissors	erasers	flutes
7	Geigen	Trompeten	Kommoden
	violins	trumpets	dressers
8	Ketten	Uhren	Beile
	chains	watches	hatchets
9	Seile	Hanteln	Brote
	ropes	dumbbells	bread
10	Spaten	Schaufeln	Narzissen
	spades	shovels	daffodills
11	Speere	Kanonen	Marder
	spears	guns	martens
12	Duschgel	Creme	Klebstifte
	shower gel	cream	glue sticks
13	Tische	Stühle	Fernseher
	tables	chairs	TVs
14	Töpfe	Gläser	Spaten
	pots	glasses	spades
15	Bälle	Puppen	Roller
	balls	dolls	scooters
16	Statuen	Plastiken	Fenster
	statues	sculptures	windows

Table A.2: Probes used in Experiments 2 and 3 (*continued*)

Item	*mentioned alternative*	*unmentioned alternative*	*unrelated*
17	Fritteusen	Rührgeräte	Armbänder
	fryers	mixers	bracelets
18	Karotten	Zucchinis	Klaviere
	carrots	zucchinis	pianos
19	Zwiebeln	Kartoffeln	Jacketts
	onions	potatoes	jackets
20	Bonbons	Lakritze	Radieschen
	candy	liquorice	radishes
21	Lilien	Tulpen	Giraffen
	lilies	tulips	giraffes
22	Bienen	Käfer	Sofas
	bees	beetles	sofas
23	Eier	Butter	Brillen
	eggs	butter	glasses
24	Kühe	Schafe	Slipper
	cows	sheep	slippers
25	Füchse	Bären	Bänder
	foxes	bear	ribbons
26	Prinzen	Zwerge	Ringe
	princes	dwarfs	rings
27	Socken	Röcke	Tassen
	socks	skirts	cups
28	Stiefel	Ballerinas	Mützen
	boots	ballett pumps	caps
29	Schals	Gürtel	Tomaten
	scarves	belts	tomatoes
30	Pflaumen	Trauben	Schlüssel
	plums	grapes	keys

A.6 Probe words used in Experiment 4

List of contrastive and non-contrastive probes corresponding to the items listed in A.3.

Table A.3: Probes used in Experiment 4

Item	*contrastive alternatives*	*non-contrastive associates*
1	Jacken	Knöpfe
	jackets	buttons
2	Beeren	Maden
	berries	maggots
3	Brause	Früchte
	lemonade	fruit
4	Löwen	Bäume
	lions	trees
5	Zangen	Äste
	pliers	branches
6	Kulis	Tinte
	biros	ink
7	Trommeln	Bögen
	drums	bows
8	Uhren	Trauung
	watches	marriage
9	Spaten	Blätter
	spades	leaves
10	Ketten	Muscheln
	necklaces	shells
11	Dolche	Jäger
	daggers	hunters
12	Creme	Dusche
	creme	shower
13	Sessel	Kleidung
	armchairs	clothes
14	Gläser	Speisen
	glasses	dishes
15	Kreisel	Gummi
	spinning tops	rubber
16	Nieren	Adern
	kidneys	veins

Table A.4: Probes used in Experiment 4 (*continued*)

Item	*contrastive alternatives*	*non-contrastive associates*
17	Mixer	Krümel
	blenders	crumbs
18	Gurken	Hasen
	cucumbers	rabbits
19	Bohnen	Suppen
	beans	soups
20	Lutscher	Zucker
	lollipops	sugar
21	Tulpen	Vasen
	tulips	vases
22	Mücken	Fühler
	mosquitos	antennae
23	Sahne	Mäuse
	cream	mice
24	Kühe	Borsten
	cows	bristles
25	Hirsche	Märchen
	deer	fairytales
26	Teufel	Besen
	devil	brooms
27	Socken	Nähte
	socks	seams
28	Betten	Polster
	beds	cushions
29	Kiwis	Likör
	kiwis	liqueur
30	Bremsen	Metall
	brakes	metall
31	Kühe	Reiter
	cows	rider
32	Lappen	Henkel
	rags	handles

Table A.5: Probes used in Experiment 4 (*continued*)

Item	*contrastive alternatives*	*non-contrastive associates*
33	Kerzen	Fassung
	candles	rims
34	Wiener	Knochen
	sausages	bones
35	Sänger	Bühnen
	singers	stages
36	Schwimmer	Trikots
	swimmers	unitards
37	Schnecken	Plankton
	snails	plankton
38	Lilien	Dornen
	lilies	dorns
39	Taschen	Schnallen
	bags	clasps
40	Hüte	Seide
	hats	silk
41	Köche	Buffet
	cooks	buffet
42	Bakterien	Grippe
	bacteria	flu
43	Höhlen	Vögel
	caves	birds
44	Tische	Lehnen
	tables	armrests
45	Flöten	Saiten
	flutes	strings
46	Ordner	Löcher
	folders	holes
47	Nägel	Bretter
	nails	boards
48	Maler	Ziegel
	painter	bricks

Table A.6: Probes used in Experiment 4 (*continued*)

Item	contrastive alternatives	non-contrastive associates
49	Herde	Wäsche
	stoves	laundry
50	Butter	Dotter
	butter	yolk
51	Kuchen	Körner
	cake	grains
52	Gallen	Husten
	biles	cough
53	Hanteln	Kordeln
	barbells	cords
54	Schlosser	Rohre
	locksmiths	pipes
55	Bürsten	Duschen
	brushes	showers
56	Kräne	Schaufeln
	cranes	shovels
57	Drachen	Kronen
	dragons	crowns
58	Pflaumen	Kerne
	plums	pips
59	Bänder	Yoga
	ribbons	Yoga
60	Boote	Schaffner
	boats	conductor

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